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A Case-Control Study on Pregnancy-Induced Hypertension and Associated Factors Among Antenatal Women Attending a Tertiary Care Centre in Chennai

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Abstract:

- ***Background:***

Particularly in low- and middle-income countries like India, pregnancy-induced hypertension (PIH) is a major cause of mother and fetal morbidity and death. In South India, the prevalence of PIH ranges from 7% to 10%, depending on a number of lifestyle and sociodemographic variables. The goal of the current study is to investigate the connection between prenatal risk factors and PIH in women who visit Chennai's tertiary care institutions.

- ***Methods:***

From November 2024 to January 2025, two tertiary care facilities in Chennai participated in a case-control research. There were 80 individuals in all, 40 of whom were PIH patients and 40 of whom were controls. A pretested semi-structured questionnaire was used to gather data, and SPSS software was used for statistical analysis. To determine the risk variables for PIH, binary logistic regression models, both unadjusted and adjusted, were employed.

- ***Results:***

Reduced interpregnancy intervals (AOR = 0.211, p = 0.03), a history of gestational diabetes mellitus (AOR = 7.595, p = 0.17), an increased gestational age (AOR = 4.243, p = 0.035), daily consumption of salt exceeding 6g (AOR = 8.188, p = 0.02), and consumption of more than 2 cups of coffee per day (AOR = 38.924, p = 0.04) were all strongly correlated with PIH. Socioeconomic level and PIH did not significantly correlate (p > 0.05).

- ***Discussion:***

The findings emphasize the role of coffee drinking, salt intake, gestational diabetes history, and interpregnancy gap in the development of PIH. These findings support the necessity of food and lifestyle modification counselling during prenatal care for women with a history of gestational diabetes or shorter interpregnancy intervals, notwithstanding several limitations, including recollection bias and selection bias.

- ***Conclusion:***

Short interpregnancy intervals, a history of gestational diabetes, excessive salt intake, and heavy coffee consumption are among the important modifiable and non-modifiable risk factors for PIH identified in this study. Although socioeconomic status was not found to be a role, further research is necessary to determine the wider socioeconomic and cultural determinants, particularly in contexts with limited resources, so that targeted treatments may be developed to prevent PIH.

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Keywords: *PIH, Antenatal Risk Factors, Diet, South Indian Women, Chennai.*

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I. INTRODUCTION

➢ *Background*

Hypertension caused by pregnancy is one of the leading factors in maternal and fetal morbidity and mortality, particularly in low- and middle-income nations such as India. In India, the occurrence of hypertensive disorders during pregnancy is estimated to be from 5% to 10%, with differences influenced by the geographic locations, socio-economic statuses, and access to healthcare.

➢ *Prevalence of Pregnancy-Induced Hypertension in South India:*

Prevalence of PIH in South India has been noted to vary from 7% to 10%, highlighting the regional characteristics of its prevalence and related factors. Numerous research studies have indicated the occurrence of PIH in South India. A tertiary care hospital-based study from Tamil Nadu reported a prevalence rate of 8.3% by Tharakan et al. (2019) that was close to the national average. The same study also noted that PIH was more common in women with higher BMI, women with a family history of hypertension, and those belonging to a lower socio-economic background. Similarly, a research study from Kerala (3) reported a prevalence rate of 9.2%, which shows how the regional health infrastructure, lifestyle, and nutrition would influence the PIH incidence rate.

Balasubramanian et al. (2016) had conducted a study in a rural part of Tamil Nadu, finding that the prevalence of PIH was 7%. (2) The leading risk factors among them were reported to pregnancy at an early age, a low socio-economic status, and inadequate prenatal care. These studies emphasize the requirement for early diagnosis and intervention tailored to the local challenges faced by women in such rural and deprived areas.

➢ *South Indian Studies Have Discussed in detail Different Risk Factors in Pregnancy Induced Hypertension:*

Maternal Age: Advanced maternal age has been described as a prominent risk factor. Primipara or first time in pregnancy is the other risk factor. A study conducted by Subramanian et al. (2017) in Tamil Nadu found that women aged 35 and above were more likely to develop PIH compared to younger women. The study reported an odds ratio (OR) of 2.4 for PIH in women aged 35 or older (4). Also, a greater incidence of PIH was reported in the context of first pregnancies, based on studies conducted in Kerala (5) and Andhra Pradesh (2).

Obesity: Obesity is one of the important modifiable risk factors for PIH in South India. A study conducted in Kerala (3), revealed that 35% of women with PIH were obese, in contrast to 18% in the control group. The rise in PIH occurrence is due to a growing prevalence of obesity influenced by shifts in diet and a more sedentary way of living.

Access to healthcare and socioeconomic status: Socioeconomic status is a strong influencer in occurrence of PIH. Low socioeconomic class women are more likely to develop PIH; this is mainly due to lack of access to healthcare, poor nutrition, and a lack of maternal health education. Das et al. (2020) found in their research conducted in Tamil Nadu that women whose monthly household income was under ₹15,000 had a higher likelihood of developing hypertension while pregnant (3).

Family Background of Hypertension: A familial history of hypertension is a recognized risk factor for PIH in South Indian communities. In a study carried out in Andhra Pradesh, Kumar et al. (2017) found that women with a family history of hypertension had a higher risk of PIH, reporting an odds ratio of 2.5 (5).

➢ *Aims and Objectives*

To identify association of socio-demographic and lifestyle factors with PIH among antenatal mothers reporting to tertiary care centres in Chennai, Tamil Nadu.

II. METHODOLOGY

➢ *Study Design:*

A case-control study Study Period: From November 2024 to January 2025 Study Centre: This study was performed at the following two tertiary care centres:

- Government Medical College and Hospital, Omandurar Government Estate, Chennai
- Institute of Social Obstetrics and Government Kasturba Gandhi Hospital, Chennai

➢ *Study Population:*

- Control Group: All the antenatal mothers coming to the tertiary care center for antenatal visits, without PIH.
- Case Group: All the antenatal mothers diagnosed to have PIH and attending tertiary care centre

➢ *Inclusion Criteria:*

- Antenatal mothers attending tertiary care centres. Table 1 Risk Factors of PIH

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➢ *Exclusion Criteria:*

- Antenatal mothers who don't give consent for the study.
- Antenatal mothers who are severely ill i.e., Eclampsia patients

➢ *Sample Size Calculation:*

- *Using Open Epi software,*

Based on previous research (e.g., Tharakan et al., 2019; Balasubramanian et al., 2016), it was estimated that the expected OR for significant risk factors such as history of gestational diabetes, high salt intake, etc. was between 2.0 to 4.0. With a 0.05 significance level and 80% power, the required sample size was estimated to be 40 cases and 40 controls totalling 80 participants to detect meaningful associations.

➢ *Ethics approval and consent to participate:*

- The study was authorized by the IEC Ethics Review Board, and individuals'
- signed consent was required to participate.

➢ *Data collection:*

Participants selected using simple random sampling, in that whomever fulfilled the inclusion criteria were included in the study. After obtaining consent, pretested semi-structured questionnaire was administered and data were collected.

➢ *Statistical Methods:*

The analysis of the data was conducted using SPSS software version 16. Descriptive statistics was employed to outline the socio-demographic, clinical, and lifestyle traits of the participants. Continuous variables were reported as mean ± standard deviation, whereas categorical variables were shown as counts and percentages. Chi square test used for comparing percentages of the categorical data and unpaired t test or Mann witney u test used for comparing means of the continuous variables. P value <0.05 indicates statistical significance.

A binary logistic regression analysis was conducted to identify the predictors of PIH. We performed both unadjusted and adjusted binary logistic models, unadjusted models helps in determining crude risk of PIH by each variable and adjusted models helps controlling potential confounders which are mostly the covariates including age, interpregnancy interval, past occurrences of gestational diabetes mellitus, gestational age, daily salt consumption, coffee intake, socio-economic background, smoking habits, and alcohol use. This allowed for the estimation of adjusted odds ratios (AOR), indicating the relationship of each predictor with PIH, regardless of the impact of other factors. The model's goodness-of-fit was evaluated through the Hosmer-Lemeshow test, where a p-value greater than 0.05 suggests a good fit. The Nagelkerke R^2 statistic was utilized to assess the variance portion accounted for by the model. Statistical significance was set at $p < 0.05$.

III. RESULTS

➢ *Descriptive Data*

80 antenatal mothers participated, 40 in the cases and 40 in controls. The case group had mean age of participants of 25.23 ±3 years which is the same as that of the control group: 25.23 ±3 years.

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Table 1 Risk Factors of PIH

Table 1: Risk factors of PIH

Variables	Control	Case	*p*
Age (in yrs)	25.23 ± 3.092	25.23 ± 3.092	1
Gestational Age (in wks)	30.73 ± 7.334	34.10 ± 5.212	0.2
BMI	26.63 ± 4.47	27.28 ± 5.40	0.559
BMI Category			
Underweight	1(100%)	0(0%)	0.759
Normal Weight	8(44.4%)	10(55.6%)	
Overweight	6(66.7%)	3(33.3%)	
Obese (Class I)	16(47.1%)	18(52.9%)	
Obese (Class II)	7(53.8%)	18(52.9%)	
Morbidly Obese (Class III)	7(53.8%)	6(46.2%)	
H/o GDM			
Yes	4(26.7%)	11(73.3%)	0.083
No	36(55.4%)	29(44.6%)	
Socioeconomic status			
Upper class	0(0%)	1(100%)	0.468
Upper-middle class	2(33.3%)	4(66.7%)	
Middle class	27(55.1%)	22(44.9%)	
Lower-middle class	10(43.5%)	13(56.5%)	
Lower class	1(100%)	0(0%)	
Education Status			
No education	4(80%)	1(20%)	0.334
Primary education	1(50%)	1(50%)	
Secondary education	13(65%)	7(35%)	
Higher secondary education	6(46.2%)	7(53.8%)	
Undergraduate degree	14(42.4%)	19(57.6%)	
Postgraduate degree	2(28.6%)	5(71.4%)	
Interpregnancy Interval			
< 2 years	8(23.5%)	26(76.5%)	**<0.001**
2 - 4 years	24(68.6%)	11(31.4%	
> 4 years	8(72.7%)	3(27.3%)	
Coffee intake			
≤4 cups per day	8(20.0%)	32(80.0%)	**0.029**
>4 cups per day	1(2.5%)	39(97.5%)	
Salt intake			
≤5 grams per day	30(69.8%)	13(30.2%)	**<0.001**
>5 grams per day	13(27%)	27(73%)	
Fruit intake			
≤1 cup per day	21(47.7%)	23(52.3%)	0.822
>1 cup per day	19(52%)	17(47.2%)	
Vegetable intake			
≤1 cup per day	21(44.7%)	26(55.3%)	0.364
>1 cup per day	19(57.6%)	14(42.4%)	
Egg intake			
none	20(48.8%)	21(51%)	0.178
1 per day	19(57.6%)	14(42.4%)	
>1 per day	1(16.7%)	5(83.3%)	

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The characteristics of both groups are summarized under Table 1. Higher proportion of control group had women with a longer interpregnancy interval of 2-4 years (68.6%) and case group had higher percentage of women with short interpregnancy interval of <2 years(76.5%) and its statistically significant (p<0.001). Similarly higher proportion of increased coffee(97.5%) and salt intake(73%) seen in case group and it is statistically significant(<0.05).

Unadjusted binary logistic regression model done for potential risk factors of PIH (Table 2), this had shown statistically significant (p= <0.05) crude odds ratio for coffee intake (Crude OR = 9.75, 95% CI= 1.158 – 82.108), salt intake (Crude OR = 6.231, 95% CI= 2.351 – 16.513) and gestational age (Crude OR= 2.714, 95% CI = 1.053 – 6.99) which shows strong positive association, whereas interpregnancy interval (Crude OR= 0.252, 95% CI = 0.116 – 0,549), shows statistically significant negative association with PIH occurrence.

Table 2 Unadjusted Logistic Regression Modal for Risk Factors of Pregnancy induced hypertension

Table 2 : Unadjusted logistic regression model for risk factors of pregnancy induced hypertension

Variables in the Equation	B	p	Crude Odds Ratio	95% C.I for Odds ratio	
				Lower	Upper
BMI category	0.052	0.078	1.054	0.731	1.519
Fruit Intake	0.202	0.653	0.817	0.338	1.974
Vegetable Intake	-0.519	0.258	0.595	0.242	1.462
Egg Intake	0.19	0.595	1.209	0.601	2.433
Socioeconomic status	-0.181	0.604	0.835	0.422	1.653
Interpregnancy Interval	-1.377	0.001	0.252	0.116	0.549
History GDM	1.228	0.053	3.414	0.983	11.85
Gestational Age Grouped	0.999	0.483	2.714	1.053	6.999
Salt Intake	1.829	0.001	6.231	2.351	16.513
Coffee Cups Per Day	2.277	0.36	9.75	1.158	82.108

Binary logistic regression after controlling the potential confounders (Interpregnancy Interval, History of GDM, gestational age, Daily salt intake, Coffee Consumption, Daily salt intake, Socio Economic Status, Smoking, Alcohol consumption) (Table 3)

➢ *Model Fit:*

The logistic regression model explained 59.2% of the variance in PIH (Nagelkerke R2= 0.592) and was a good fit to the data: Hosmer – Lemeshow Test, p = .248 i.e. Null hypothesis accepted, there is no significant difference between observed and predicted values.

➢ *Significant Predictors (by Coefficients Tables)*

- Interpregnancy interval: AOR = 0.211, CI= 0.77 – 0.581, p = 0.03
- History of GDM: AOR = 7.595, CI=1.437 – 40.161, p = 0.17
- Gestational Age: AOR = 4.243, CI = 1.107 – 16.263, p = 0.035
- Daily Salt Intake > 6g/day: AOR = 8.188, CI= 2.207 – 30.378, p = 0.02
- Coffee Consumption (>2 cups/day): AOR = 38.924, CI = 3.289 – 460.5, p=0.04

➢ *Non-Significant Predictors (by Coefficients Tables)*

Socio-Economic Status, Smoking, and Alcohol Consumption were not Significantly linked with PIH (p > 0.05). (Table 3)

Table 3 Logistic Regression Modal for Risk Factors of Pregnancy induced hypertension adjusted for potential confounders

Table 3 : Logistic regression model for risk factors of pregnancy induced hypertension adjusted for potential confounders

Variables in the Equation	B	p	Adjusted Odds Ratio	95% C.I for Odds ratio	
				Lower	Upper
BMI category	-0.043	0.84	0.958	0.632	1.452
Fruit Intake	0.214	0.733	1.238	0.362	4.237
Vegetable Intake	-0.753	0.225	0.471	0.14	1.588
Egg Intake	0.029	0.945	1.03	0.443	2.394
Socioeconomic status	0.018	0.965	1.018	0.448	2.314
Interpregnancy Interval	-1.554	0.003	0.211	0.077	0.581
History GDM	2.028	0.017	7.595	1.437	40.161
Gestational Age Grouped	1.445	0.035	4.243	1.107	16.263
Salt Intake	2.103	0.002	8.188	2.207	30.378
Coffee Cups Per Day	3.662	0.004	38.924	3.289	460.598
Constant	-2.524	0.168	0.08		

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IV. DISCUSSION

As per results the risk factors for PIH include the shorter interpregnancy interval, previous diagnosis of GDM, the gestational age, salt intake, and coffee consumption.

- Interpregnancy interval: the shorter the interval between pregnancies was a significant risk predictor for developing PIH: Negative association.
- History of GDM: was linked to a 7.5-fold increased risk of PIH
- Gestational Age: Earlier gestational age was significantlyassociated
- Daily Salt Intake >2g/day: was linked to an 8-fold increased risk of PIH
- Coffee Consumption: Higher caffeine intake (>2 Cups/Day) was linked to a 38-fold increased risk of PIH
- Such findings are consistent with previous literature focu sing on lifestyle and antecedent obstetric history in the aetiology of PIH (3) (1) (5).

Findings **emphasize a need for routine diet and lifestyle modification counselling** during antenatal visits, primarily on women with a history of GDM or with shorter interpregnancy.

The lack of association between socio-economic status differs from some other studies in literature review, but it may be because of the relatively homogenous socio-economic profile of population studied. It can mitigate the influence of Socioeconomic status in PIH.

It therefore emphasizes the role of such **context-specific factors** in PIH risks. While the findings are context-specific to South Indian urban populations; they may differ in rural or resource-limited settings due to socio-economic, cultural, and healthcare access drastic their differences among these settings. Future research should be made emphasizing role of context specific factors like **SES, healthcare accessibility, cultural norms,** for considering more Tailored interventions to our population.

And Notably, AOR of daily coffee consumption was 48.9, although previous literature have reported positive association between coffee consumption and PIH, the magnitude here may reflect biases inherent in study design - recall bias, selection bias, confounding factors like stress, etc which may not be adequately controlled. Also demands a need for health education to antenatal mothers about the effect of coffee consumption and its alternatives.

- *Strengths*

- Selection bias was minimised by using simple random sampling.
- Recall bias was minimised by cross verifying medical records alongside structured interviews (Questionnaire).
- Potential confounders are controlled by using statistical adjustments like logistic regression.

- *Limitations*

Limitations noted when interpreting the findings of this study are:

- Selection bias, Homogeneity of study population
- Recall bias could have influenced the precision of data gathering, particularly concerning self-reported lifestyle elements like coffee intake.
- The research was conducted in a tertiary care environment, which might not adequately reflect the overall population, particularly in rural or underprivileged regions where access to healthcare is restricted.
- Possible unmeasured confounders such as psychological stress or undiagnosed health issues may be affecting the identified risk factors associated with PIH.

V. CONCLUSION

This research has notably offered understanding regarding the risk factors linked to pregnancy-induced hypertension, including a brief interpregnancy interval, prior gestational diabetes mellitus, gestational age, high salt intake, and elevated coffee consumption. In this study, there was no significant association between socio-economic status and PIH. This may be due to the homogeneity of the study population. The association between high coffee consumption and PIH requires further investigation since it may be influenced by biases such as recall bias and confounding factors. More emphasis needs to be put on exploring socio-economic factors, access to health care, and cultural beliefs influencing the onset of PIH in resource-poor settings in order to come up with more personalized interventions for those women at risk. More sizable and heterogeneous studies are required in order to clearly define the multifaceted relationship of genetic, lifestyle, and environmental elements which lead to the development of PIH.

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- *Declarations*

- *Conflict of interests*

The authors declare no conflict of interests.

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➢ *Abbreviations:*

AOR: Adjusted Odds Ratio

ANC: Antenatal Care

BMI: Body Mass Index

CI: Confidence Interval

GDM: Gestational Diabetes Mellitus

IEC: Institutional Ethics Committee

OR: Odds Ratio

PIH: Pregnancy-Induced Hypertension

SES: Socio-Economic Status

SPSS: Statistical Package for the Social Sciences

WHO: World Health Organization

SD: Standard Deviation

df: Degrees of Freedom

p-value: Probability Value

Nagelkerke R^2: Nagelkerke Pseudo R-Square

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