



Hypertension and its correlates among pregnant women consuming tobacco in India: Findings from the National Family health Survey-4

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ABSTRACT

Background: Hypertension (high blood pressure) during pregnancy has significant implications on maternal and perinatal morbidity and mortality. Tobacco use during pregnancy amplifies this burden and increases the risk of hypertensive disorders along with adverse birth outcomes. The current study aimed to evaluate the joint risk at population-level of tobacco use and hypertension among pregnant women in India.

Methodology: Data of 32,428 “currently pregnant” women aged 15–49 years was obtained from the National Family Health Survey (NFHS-4) 2015–16 to estimate bivariate (tobacco user vs. non-user) and binomial logistic regression analysis in order to get odds ratios of having hypertension. The analysis included socio-demographic variables such as the respondent's age, type of residence, wealth index, and education status.

Results: Prevalence of hypertension among pregnant tobacco users (7.5%) was significantly higher than that of non-users (6.1%). The unadjusted odds of having hypertension were 1.17 (95% CI: 1.02–1.35) times among tobacco users than non-users and increased with age ($p < 0.001$) and in rural areas ($p = 0.02$) after adjusting for other covariates. However, it varied inversely with education status ($p > 0.05$; NS) and wealth quintile ($p = 0.01$).

Conclusion: The present study identifies the higher co-existence of hypertension among tobacco-using pregnant women and highlights the need for tobacco control/cessation and hypertension prevention and management during pregnancy considering socio-demographic disparities.

1. Introduction

Hypertension (high blood pressure) is a most common encountered medical problem during pregnancy, with significant implications on maternal and perinatal morbidity and mortality. It accounts for >30 thousand maternal deaths annually globally and maternal deaths of 10%–15% among low- and middle-income countries (Hafez et al., 2014; Wu et al., 2017). A multi-centric study reported that one out of every ten women experiences hypertension during pregnancy (Magee et al., 2019). The adverse effects of high blood pressure during pregnancy are termed Hypertensive disorders during pregnancy and include conditions, such as chronic hypertension existing prior to pregnancy,

gestational hypertension, and preeclampsia, which accounts for a combined prevalence of nearly 14% in India (Magee et al., 2019).

This burden of hypertension and associated disorders further amplifies with tobacco consumption (smoking or smokeless) during pregnancy. The available evidence indicate tobacco use as a risk factor for hypertension (Primatesta et al., 2001; Bolinder et al., 1992; Westman, 1995), increased risk of hypertensive disorders and other adverse birth outcomes among women of child bearing age (Datta and Husain, 2021), thereby implying complex relationship between the entangled issues of hypertension and tobacco use.

Though the evidence exists on tobacco use (Suliankatchi and Sinha, 2016; Singh et al., 2015) and hypertension (Magee et al., 2019; Agrawal

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and Fledderjohann, 2016; Nath et al., 2021) among pregnant women in India, the prevalence and determinants for each condition were assessed separately by most studies, and very few studies reported an association between use of tobacco and hypertension in pregnancy (Wang et al., 2022; Guðnadóttir et al., 2016). The National Family Health Survey (4th Round, 2015–16) is a symbolic representation of the health status of the Indian population and covers a broad spectrum of public health issues, including maternal and child wellbeing (IIPS, 2017).

India is one of the largest tobacco-consuming nations, and nearly 65 million women (14.2% of the adult population aged > 15 years) consume tobacco in the country (WHO, 2018), which is an enormous population subset. In addition, evidence points towards high prevalence estimates of hypertension (up to 23.6%) among women in a nationally representative survey of India (Geldsetzer et al., 2018).

Considering the impact of tobacco use on hypertension among women, especially during vulnerable phases such as pregnancy (Wang et al., 2022), it is imperative to understand the risk estimates of hypertension at a population level so that maternal and subsequent neonatal healthcare can be managed adequately. With this background, the current study, thus focused on pregnant women in India to assess the prevalence of hypertension and determine its associated risk factors including tobacco use so as to form a basis for coordinated management of hypertension and tobacco control strategies and augment the importance of tobacco cessation during antenatal check-ups.

2. Material and Methods

Data Source: The data for the study was collected from a cross-sectional study named National Family Health Survey (NFHS-4), India (4th round). The survey was conducted by Ministry of Health and Family Welfare (MoHFW), Government of India, and covered 29 states with seven union territories of India. The NFHS is a large scale, multi-round survey that is usually conducted in randomly selected, representative sample of households. The first survey was conducted in 1992–93 followed by second round in 1998–99 while third and fourth rounds were held in 2005–06 and 2015–16 respectively. The main purpose of these surveys is to assess emerging health and family welfare issues and implicate policy and practice in India.

Two-stage cluster random sampling was used for this survey to collect the data using population proportionate to size (PPS) sampling methodology (IIPS, 2017). The data was collected in two phases (from January 20, 2015, to December 4, 2016) by trained field staff members and supervisors to verify data accuracy by spot-checking.

Study population: In the current study, a subset of the survey respondents, pregnant women aged between 15 and 49 years and living at their usual residence before the survey date was included. Non-pregnant women and women who were not sure about their pregnancy status were excluded from the analysis. All currently pregnant women (self-reported) were included in the analysis regardless of their trimester status. The final analysis included 32,428 currently pregnant women (nearly 4.8% of the total female population surveyed in NFHS-4).

Variables related to tobacco use: Respondents' self-reported data was collected on the current use of tobacco products, smoked (e.g., cigarette, bidi, hookah, cigar, pipe, etc.) and/or smokeless (e.g., paan with tobacco, paan masala or gutkha, khaini, chewing tobacco, snuff, etc.). A respondent reporting consumption of one or more tobacco products mentioned above was identified as a tobacco user and included in the study.

Variables related to hypertension: Omron Blood Pressure monitor was used for reporting the NFHS-4 survey Blood Pressure (BP) measurements. In the survey, the participants were encouraged to restrict alcohol and smoking and not consume any caffeinated beverages at least 30 min before measuring BP. At the time of assessment, participants were asked to relax for at least 5 min prior and to place left arm on the table in a resting position at heart level. In a single visit, both the readings of BP, Systolic blood pressure (SBP) and diastolic blood pressure

(DBP) measurements were recorded three times with at least five minutes of an interval between each. Respondents were identified as hypertensive if SBP \geq 140 mmHg or DBP \geq 90 mmHg. However, three readings taken were utilized individually for statistical comparison, and the individual was considered 'Hypertensive' if SBP or DBP crossed the cut-off limits in average of three readings and any of the three measures in case only one reading was available (First, second, third reading missing for 1.3% (n = 437), 2.5% (n = 814) and 4.5% (n = 1468) of sample, respectively). The overall prevalence of hypertension and Systolic and Diastolic hypertension measures were calculated and compared between independent variables ([12]).

Other variables: Socio-demographic characteristics included age (categorized under 5-year interval groups from 15 to 49 years), residence type, education level, and wealth index (wealth quintiles).

Data analysis: To analyze the dataset, Statistical Package of Social Sciences (SPSS) software version 21 was used. While descriptive statistics was used for characterization of study population and their tobacco use status. The differences in the prevalence of hypertension with tobacco use status were controlled for multiple covariates including age group in years [15–19 (reference category), 20–24, 25–29, 30–34, 35–39, 40–44, and 45–49], type of residence [rural (reference category)/urban], educational level [No education (reference category), Primary, Secondary, and Higher] and wealth index [Poorest (reference category), Poorer, Middle, Richer, and Richest quintiles].

To assess the association between the independent and dependent variable (hypertension) in the study, Chi-square/Fisher exact test was applied. To quantify the strength of association unadjusted odds ratios (ORs) with 95% confidence intervals was determined. While unpaired *t*-test was applied for comparing parametric SBP and DBP values among pregnant tobacco users and non-users.

A binomial logistic regression analysis was applied to estimate the adjusted measures of differences in the status of hypertension between the tobacco user and non-user groups. The binary variable indicating the presence or absence of hypertension among the respondents was the outcome variable. The items with p-value up to 0.15 in the bivariate analysis were included in regression model. The logistic regression model estimated unadjusted as well as adjusted (for covariates including age, type of residence, education status, and wealth quintile) measures of difference in hypertension among tobacco users and non-users groups. The reported data with a P-value < 0.05 in the study was considered statistically significant.

3. Results

3.1. Descriptive and bivariate analysis

In the NFHS-4, a total of 32,428 women were pregnant at the time of the survey. Among them, 8.3% of pregnant women (n = 2677) reported some form of tobacco use. A total of 7.0% (n = 2269) consumed smokeless forms of tobacco, nearly 1.0% (n = 316) consumed smoking forms of tobacco, and around 0.3% (n = 92) consumed both forms of tobacco, smoking and smokeless (dual-user). Tobacco use was less prevalent in younger pregnant women, and its proportion increased gradually with age. This gradual increase was statistically significant. The mean age of tobacco users was significantly higher as compared to non-users (Table 1).

Further, tobacco use was proportionately and significantly higher among pregnant women residing in rural (8.7%), as compared to urban (6.9%) areas, and among the poorest (12.1%) than wealthier quintiles (richer: 5.7%; richest: 3.3%). Tobacco use gradually decreased with rising levels of education (inversely-related) (Table 1).

From the blood pressure variables, the mean 1st and 2nd SBP measures and 1st and 3rd DBP measures were significantly higher among pregnant women using tobacco compared to non-users. Among the respondents, the prevalence of systolic hypertension of tobacco users was 3.4%, which was significantly higher than non-users (2.3%). The

Table 1
Prevalence of tobacco consumption across socio-demographic characteristics of pregnant women and its associated factors.

| Variables | Tobacco users N (%) | Non-users N (%) | Total N | P value |
|--------------------------|------------------------|--------------------|----------------|-----------------|
| Total | 2677 (8.3) | 29,751 (91.7) | 32,428 | |
| Age (Mean + SD) | 26.7 ± 5.8222 | 24.5 ± 4.73464 | 24.7 ± 4.93686 | <0.001* Ref |
| 15–19 years | (6.0)805 | (94.0) | (11.4) | 0.71 |
| 20–24 years | (5.9)869 | (94.1) | (42.4) | <0.001* |
| 25–29 years | (8.9)469 | (94.1) | (42.4) | <0.001* |
| 30–34 years | (12.8)230 | 8944 | 9813 | <0.001* |
| 35–39 years | (18.9)61 | (91.1) | (30.3) | <0.001* <0.001* |
| 40–44 years | (24.0)21 | 3185 | 3654 | |
| 45–49 years | (29.6) | (87.2)985 | (11.3) | |
| | | (81.1)193 | 1215 | |
| | | (76.0)50 | (3.7)254 | |
| | | (70.4) | (0.7)71 | |
| | | (0.2) | | |
| Type of residence | 2141 (8.7) | 22,469 (91.3) | 24,610 (75.9) | <0.001* |
| Urban | | | | |
| Rural | | | | |
| Wealth | 774 (10.2) | 6842 (89.8) | 7616 (23.5) | <0.001* |
| Index Poorest | 491 (7.4)315 | 6106 (92.6) | 6597 (20.3) | <0.001* <0.001* |
| (1st Quintile) | (5.7)164 | (3.3) | 5260 | |
| Poorer | | | 5575 | |
| (2nd Quintile) | | | (94.3) | |
| Middle | | | (17.2) | |
| (3rd Quintile) | | | 4793 | |
| Richer | | | (96.7) | |
| (4th Quintile) | | | (15.3) | |
| Richest | | | | |
| (5th Quintile) | | | | |
| Education status | 508 (11.9) | 3772 (88.1) | 4280 (13.2) | 0.61 |
| No education | 1112 (6.9) | (93.1) | (49.6) | <0.001* <0.001* |
| Primary | 115 | 14,962 | 16,074 | |
| Secondary | (2.9) | 3810 | 3925 | |
| Higher | | (97.1) | (12.1) | |

*Percentages (%) were calculated horizontally in each subset individually.

findings were similar for diastolic hypertension (6.6% and 5.1% among tobacco users and non-users, respectively). The overall hypertension prevalence was thus significantly higher among pregnant tobacco users (7.5%) compared to non-users (6.1%) (Table 2).

Upon evaluating the overall prevalence of hypertension with socio-demographic variates (type of residence, education status, and wealth quintile); the prevalence of hypertension among tobacco users was

Table 2
Association of hypertension with tobacco use:

| Blood Pressure | Tobacco users | Non-users | P-value |
|--|---------------|---------------|--------------|
| Total | 2677 (8.3) | 29,751 (91.7) | 32,428 |
| Systolic Blood Pressure (in mm Hg) | 112.4 ± 14.1 | 111.6 ± 17.4 | 0.018* |
| Mean ± SD | 108.2 ± 12.6 | 109.3 ± 18.7 | 0.001*0.42 |
| 1st reading | | 107.8 ± 19.6 | |
| 2nd reading | | 107.8 ± 19.6 | |
| 3rd reading | | | |
| Diastolic Blood Pressure (in mm Hg) | 74.7 ± 11.2 | 73.8 ± 10.5 | <0.001* |
| Mean ± SD | 73.7 ± 31.1 | 72.7 ± 28.5 | 0.10 <0.001* |
| 1st reading | | 71.9 ± 31.7 | |
| 2nd reading | | | |
| 3rd reading | | | |
| Overall prevalence of Hypertension | 202 (7.5%) | 1819 (6.1%) | 0.01* |
| Prevalence of Systolic hypertension | 92 (3.4%) | 693 (2.3%) | <0.001* |
| Prevalence of Diastolic hypertension | 178 (6.6%) | 1529 (5.1%) | 0.002* |

higher than non-users in both rural and urban pregnant women at the time of the survey (8% and 7.4% prevalence among tobacco users, and 6.4% and 6% prevalence among non-users, in rural and urban areas respectively) (Fig. 1b). A similar pattern was observed when hypertensive tobacco users and non-users were plotted according to their wealth quintile. Hypertension prevalence was more among pregnant women consuming tobacco in all wealth quintiles, except for the richest category, where prevalence was higher among non-users (Fig. 1c). Further, the prevalence was found higher among tobacco users in all education categories than non-users (Fig. 1a).

3.2. Binomial logistic regression analysis

Table 3 presents both the unadjusted as well as adjusted odds ratios (OR) of developing hypertension. The odds were 1.17 times (unadjusted) among pregnant tobacco users for having hypertension compared to non-users. This correlate was statistically significant. However, upon adjusting tobacco use with age, education, type of residence, and wealth covariates, the odds of hypertension with tobacco use became statistically not significant (OR = 1.08).

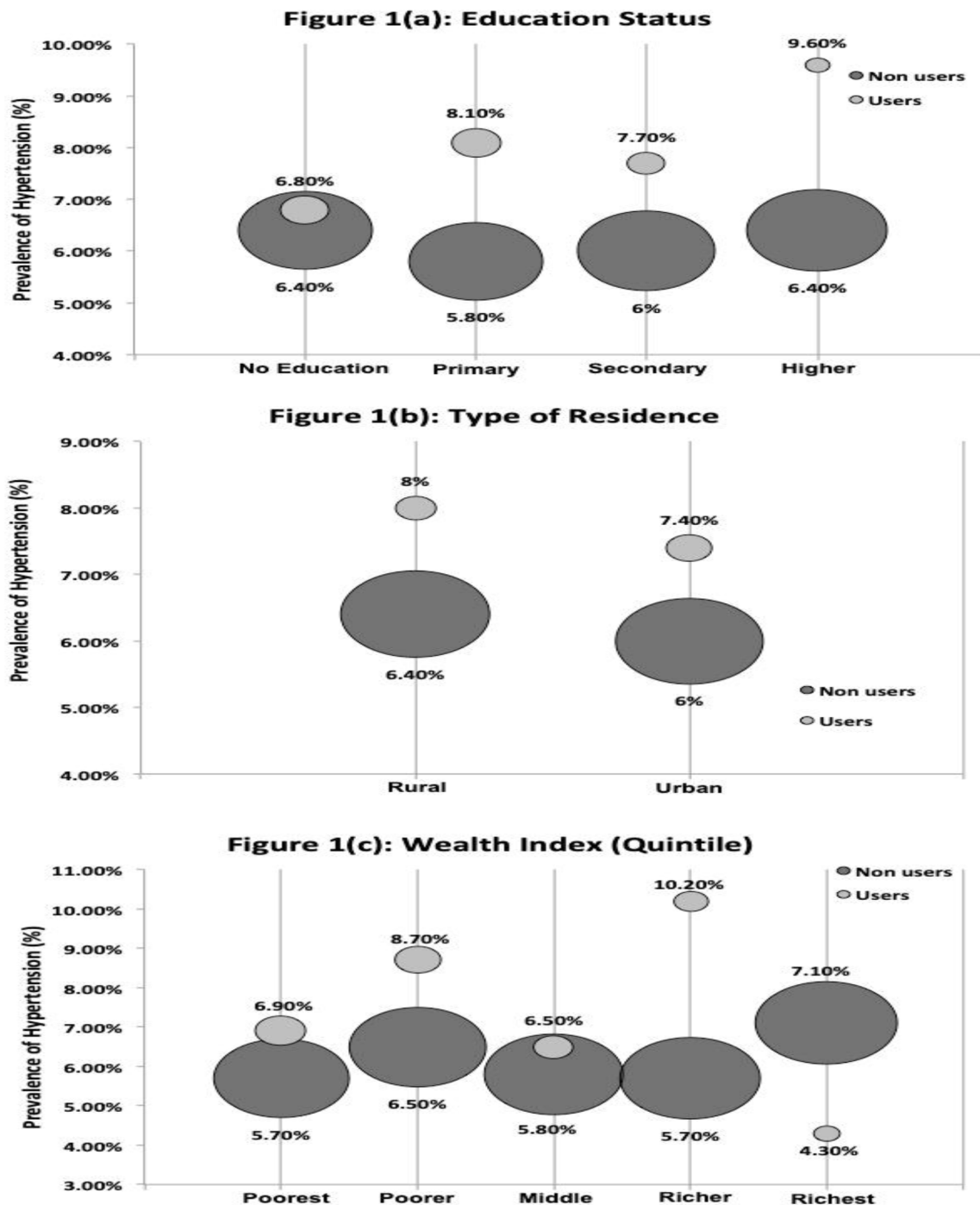
The odds for hypertension were significantly less in the younger age when adjusted with covariates. The age range of 20–39 years was protective against having hypertension (Adjusted OR < 1.0), however, senior age groups had no significant association with hypertension. The odds for hypertension were significantly higher for pregnant women residing in rural areas (OR = 1.25 unadjusted and OR = 1.13 times when adjusted for covariates).

Across the education status categories, the odds of hypertension increased with advancing education levels. However, the outcome was not statistically significant when adjusted with covariates. A varied pattern was observed in the wealth index quintiles. Compared with the poorest category (1st quintile), the odds for hypertension were significantly lower in all other wealth quintiles, except for the middle wealth category (3rd quintile), where the correlate was statistically not significant.

4. Discussion

The current study examined the association of hypertension in pregnancy with socio-demographic factors and tobacco use, as the evidence is limited for co-prevalence of the two public health problems during pregnancy in Indian settings (Datta and Husain, 2021). The secondary analysis of NFHS-4 data indicated that 8.3% of pregnant women consumed tobacco in any form, which was slightly less than that reported during NFHS-3 (2005–06) (Mistry and Dasika, 2017). The findings of the current study thus highlight the impact of initiatives for tobacco control undertaken in last two decades in the country to combat this epidemic (Blog, 2017). The observation that smokeless tobacco consumption is predominant among pregnant women is consistent with NFHS-3 and all other studies done in India (Mistry and Dasika, 2017; Pasupuleti et al., 2021). Social sanction, lesser costs and easy availability of smokeless forms of tobacco could be responsible for its pervasive use among women in general in India (Pasupuleti et al., 2021). Thus, it is pertinent to consider pregnancy as window of opportunity for tobacco control and prevention interventions.

The study also revealed the socio-demographic differentials concerning tobacco use during pregnancy. Tobacco use significantly increased with age and rural areas, while it differed inversely with education status and wealth quintile. The results corroborate findings from previous studies wherein the burden of tobacco use was shared more among socially disadvantaged women during pregnancy (Mistry and Dasika, 2017; Tanaka et al., 2019). While the increasing prevalence of tobacco use with age directs towards women's autonomy, the pattern among the poorest quintile of respondents points to the need for concerted efforts to curb the menace among the socio-economically deprived population. Besides, it is well known that tobacco is widely



*The size of the bubbles indicates the number of pregnant women (sample size) present in the respective category of residence.

**The percentage outside the bubbles indicates percentage prevalence of Hypertension among pregnant tobacco users/ non-users.

Fig. 1. Prevalence of hypertension among pregnant tobacco users/non-users as per a) Education status, b) type of residence, b) wealth index (quintiles):*The size of the bubbles indicates the number of pregnant women (sample size) present in the respective category of residence. **The percentage outside the bubbles indicates percentage prevalence of Hypertension among pregnant tobacco users/ non-users.

available in areas of lower socioeconomic status, which propels its use among the poorer 22. Interestingly, the prevalence of tobacco use was higher among pregnant women in rural areas in the current analysis. Several surveys across India and abroad have reported similar pattern of prevalence of tobacco use 23–25.

Our study showed that pregnant tobacco users have a higher prevalence of hypertension. The association of smoking during pregnancy

with a higher risk of hypertensive disorders was observed in the study by Hanaka et al. in Japan in 2019(Tanaka et al., 2019). Also, ample evidence exists that smokeless tobacco consumption can aggravate hypertensive conditions (National Cancer Institute and Centers for Disease Control and Prevention, 2014). It is speculated that nicotine induce abnormal placentation which is associated with increased risks of pre-eclampsia (Wikström et al., 2010). The finding demonstrate the need

Table 3

Factors associated with of Hypertension (present/absent) among pregnant women (binary logistic regression analysis).

| Variables | Unadjusted Odds Ratio(95% CI) | Adjusted Odds Ratio(95% CI) | P value |
|--------------------------|-------------------------------|-----------------------------|------------|
| Tobacco use (Yes) | 1.17 (1.02–1.35)* | 1.08 (0.93–1.25) | 0.30 |
| Age | 0.28 (0.15–0.52) | 0.26 (0.14–0.49) | <0.001* |
| 15–19 years | *0.29 | 0.28 | <0.001* |
| 20–24 years | (0.16–0.55)*0.39 | (0.15–0.51)0.36 | <0.001* |
| 25–29 years | (0.22–0.73)*0.50 | (0.19–0.68)0.46 | 0.013* |
| 30–34 years | (0.27–0.92)*0.65 | (0.25–0.85)0.61 | 0.120.92 |
| 35–39 years | (0.35–1.22)0.98 | (0.33–1.14)0.96 | |
| 40–44 years | (0.49–1.95) | (0.49–1.91) | |
| 45–49 years | | | |
| Type of residence | 1.25 (1.14–1.37)* | 1.13 (1.02–1.26) | 0.02* |
| UrbanRural | | | |
| Education status | 0.85 (0.74–0.97) | 0.95 (0.81–1.12) | 0.57 |
| No education | *0.78 | 0.92 | 0.370.89 |
| Primary | (0.66–0.91)*0.84 | (0.77–1.10)1.01 | |
| SecondaryHigher | (0.74–0.96)* | (0.88–1.16) | |
| Wealth | 0.68 (0.60–0.78) | 0.76 (0.64–0.90) | 0.002* |
| IndexPoorest | *0.78 | 0.89 | 0.17 |
| (1st Quintile) | (0.69–0.89)*0.72 | (0.77–1.05)0.81 | 0.01*0.01* |
| Poorer | (0.63–0.82)*0.78 | (0.70–0.95)0.83 | |
| (2nd Quintile) | (0.68–0.89)* | (0.72–0.96) | |
| Middle | | | |
| (3rd Quintile) | | | |
| Richer | | | |
| (4th Quintile) | | | |
| Richest | | | |
| (5th Quintile) | | | |

to institute tobacco control/cessation measures during the antenatal period and address hypertension with tobacco use for better maternal and neonatal outcomes.

A higher prevalence of hypertension among pregnant tobacco users was found in rural areas in the present study. The findings were consistent with a study conducted elsewhere in India (Mehta et al., 2015). The social acceptability of tobacco products, culture, policies, and limited access to health services are the reasons that impact the health status of the population living in rural areas (American Lung Association, 2015). Hence, there is a need for stringent implementation of tobacco ban, particularly in rural areas. We also found a higher prevalence of hypertension among tobacco users who had received higher education and belonged to richer wealth quintile. Sachdeva et al. have reported a higher incidence of pregnancy-induced hypertension among literate women. A study by Satapathy et al in aspirational state of Odisha higher risk of hypertension among richest wealth strata (Satapathy et al., 2022). A higher prevalence of hypertension among tobacco users of the rich wealth quintile could be attributed to a sedentary lifestyle, improper nutrition, and lack of physical activity (Sachdeva et al., 2011). This calls for targeted interventions accounting for socio-economic differentials of Indian population of pregnant women.

The odds of hypertension were lower in younger age groups, with 20–39 years protective against hypertension. The findings are congruent with studies done elsewhere [28,0.29]. Advanced maternal age increases the odds of complications such as pre-term labour, poor fetal growth, fetal distress and severe pre-eclampsia (Cavazos-Rehg et al., 2015). The effect gets exacerbated with tobacco use during pregnancy by older women that also reflect the autonomy women enjoy with increasing age (Lamminpää et al., 2013).

The current study had several limitations. Firstly, the NFHS-4 survey being cross-sectional limited the establishment of temporal association and measurement of hypertension with tobacco usage over time. Secondly, the inconsistency in self-reported tobacco use status was a potential limitation that affected the reliability (Wellman and O'Loughlin, 2015; Kaestle, 2015). Thirdly, other risk factors of hypertension such as the presence of obesity, intake of an unhealthy diet, family history of hypertension, and presence of co-morbid conditions such as diabetes

were not studied.

Notwithstanding these limitations, the study did provide valuable insights into an entwined aspect of hypertension and tobacco use during pregnancy in India. The study also revealed health disparities and socioeconomic inequalities in terms of tobacco use and hypertension. It calls for concerted tobacco control and hypertension prevention and management efforts during pregnancy, considering socio-demographic disparities. There is a need to explore more on this issue for better maternal and neonatal health outcomes.

Ethical considerations

NFHS-4 India dataset used is available in the public domain from the Demographic and Health Surveys (DHS) website for researchers (The DHS Program, 2021). The ethical approval for study was obtained from the Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, Institute Ethics Committee (PGI/IEC/2019/002357).

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CRedit authorship contribution statement

Shekhar Grover: Conceptualization, Methodology, Formal analysis, Software, Writing – original draft. **Tanu Anand:** Conceptualization, Methodology. **Jugal Kishore:** Data curation. **D.N. Sinha:** Supervision. **Sumit Malhotra:** Project administration. **Priyanka Dhawan:** Writing – review & editing. **Sonu Goel:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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