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Review Article

Hypertensive Disorders of Pregnancy in Rural and Urban Populations: A Global Scoping Review

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Abstract

Background: Pregnancy-associated hypertensive disorders (HDP) are important predictors of maternal and neonatal health outcomes, particularly for rurality-based as well as under-represented groups. Although of large magnitude, detailed data of HDP among them continue to remain lacking. ***Aim and Objective:*** The scoping review seeks to map the literature on the prevalence, risk factors, management strategies, and outcomes of HDP among underrepresented groups and those living in the countryside, highlighting gaps in the current evidence base. The research sought to pose the question: "What is the prevalence, what are the risk factors associated with it, how is management of hypertensive disorders of pregnancy addressed at the moment among the people living in the countryside or among underrepresented groups of people, and what interventions hold promise for outcome improvement?" ***Methods:*** PubMed, Scopus, and Web of Science were systematically searched for 2016-2025 publications. Publications were included where HDP was described among the rural or disadvantaged groups. Data was extracted and thematically synthesized in the context of descriptors. ***Results:*** Sixteen studies were included. There was variability in the prevalence of HDP among the studies. Risk factors identified included socioeconomic status, access to medical care, and educational attainment. Treatment measures tended to be basic and variable between the rural and the urban areas. ***Conclusion:*** A pressing necessity exists for specific interventions and policy frameworks aimed at addressing Health Disparities among rural and marginalized populations. Subsequent research should concentrate on the establishment of standardized data gathering methods, the assessment of intervention efficacy, and the incorporation of technological innovations to enhance maternal health results within these communities.

Keywords: ***Hypertensive disorders, pregnancy, rural populations, underrepresented groups, prevalence, risk factors, management.***

Introduction

Hypertensive disorders of pregnancy (HDP), which include conditions such as preeclampsia, eclampsia, and gestational hypertension, pose a considerable challenge to global health. These disorders rank among the primary contributors to maternal morbidity and mortality, especially in settings with limited resources. The World Health Organization has underscored the necessity for comprehensive strategies to address HDP, highlighting the significance of comprehending its prevalence, associated risk factors, and management practices across various populations. Hypertensive disorders of pregnancy impact up to 10% of all pregnancies and are responsible for roughly 18% of maternal deaths worldwide, equating to an estimated 62,000 to 77,000 fatalities annually (Ábalos *et al.*, 2014). The prevalence of these conditions is experiencing an upward trend, having risen by approximately 10.92% globally from 1990 to 2019, with substantial consequences for both maternal and infant health outcomes (Chen *et al.*, 2022). In the United States, hypertensive disorders of pregnancy affect about 15% of women throughout their reproductive years and account for 31.6% of maternal deaths occurring during hospitalization (Palatnik & Kulinski, 2024). On a global scale, the incidence of hypertensive disorders of pregnancy has surged by over 10% over the past two decades, impacting more than 18.08 million women (Koi-Larbi *et al.*, 2024).

In the rural areas and underserved groups, the problem of HDP tends to be aggravated by the lack of access to care, social inequalities, as well as differences in culture. These groups also tend to encounter delays in diagnosis and treatment, resulting in adverse outcomes for the mother and newborn. There continues to be little syntheses of evidence documenting the magnitude of the problem of HDP in the specified groups.

The existing body of literature concerning hypertensive disorders of pregnancy (HDP) primarily concentrates on urban environments, resulting in a paucity of representation for rural and marginalized populations. This imbalance in research emphasis has created a notable deficiency in understanding the specific epidemiological trends, risk factors, and management approaches relevant to rural and underrepresented communities. Furthermore, the efficacy of interventions designed for these groups has not been thoroughly assessed. Thus, there is a pressing need for a detailed examination of the incidence, prevalence, and outcomes of HDP within these underserved regions to inform targeted strategies and policy development (Harris *et al.*, 2020). The objective of this systematic review is to fill this vital gap by consolidating existing evidence related to the prevalence, risk factors, and adverse outcomes linked to hypertensive disorders of pregnancy in rural and

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underrepresented populations (Singh *et al.*, 2023) (Sun *et al.*, 2025) (Hu *et al.*, 2023). Such an evaluation is essential for formulating equitable healthcare strategies and enhancing maternal and neonatal health outcomes in these frequently neglected demographic segments (Ábalos *et al.*, 2013). In particular, this review will investigate how disparities in healthcare infrastructure, socio-economic factors, and cultural norms in rural contexts influence the unique manifestations and progression of HDP, ultimately steering the development of context-specific clinical guidelines and public health interventions (Liu *et al.*, 2025).

The aim of this scoping review was the systematic discovery of the available evidence on HDP among minority groups and rural groups, for the purpose of providing the answer for the question: "What is the prevalence, what risk factors are associated, and how the management of hypertensive disorders of pregnancy is now conducted among minority groups or among rural groups, and where interventions promise outcome improvement?"

Methodology

Framework and Reporting Guidelines

This scoping review was conducted following the Joanna Briggs Institute (JBI) methodology for scoping reviews and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines.

Study Design: Scoping review

Study period: 2016-2025

Sample Size: A combined total of ~51,126,487 pregnancies and participants were analyzed.

Research Question

The review aimed to address the following research question:

"What is the prevalence, what are the associated risk factors, and how is the management of hypertensive disorders in pregnancy currently addressed in rural or underrepresented populations, and what interventions show potential for improving outcomes?"

Eligibility Criteria

The eligibility criteria were defined a priori and guided by the Population, Concept, Context, and Outcomes (PCCO) framework:

Population: Pregnant women from rural, remote, or underrepresented populations.

Concept: Hypertensive disorders of pregnancy, including gestational hypertension, preeclampsia, eclampsia, and severe hypertensive disorders.

Context: Rural, semi-urban, and underrepresented or low-resource healthcare settings globally.

Outcomes: Prevalence, risk factors, management approaches, maternal and perinatal outcomes, intervention effectiveness.

Inclusion Criteria

- Original research articles published between 2016 and 2025.
- Peer-reviewed articles indexed in PubMed, Scopus, or Web of Science.
- Studies reporting prevalence, risk factors, management, or outcomes of hypertensive disorders in pregnancy in rural or underrepresented populations.
- Quantitative, qualitative, or mixed-methods designs, including cross-sectional, cohort, case-control, and intervention studies.
- Articles available in full text in English.

Exclusion Criteria

- Studies focused exclusively on urban populations without rural or underrepresented data.
- Case reports, editorials, commentaries, conference abstracts, and narrative reviews.
- Animal or experimental laboratory studies.
- Information Sources and Search Strategy

A comprehensive literature search was conducted in PubMed, Scopus, and Web of Science to identify relevant studies published from 2016 to 2025. The search strategy combined controlled vocabulary (MeSH terms) and free-text keywords related to:

"Hypertensive disorders of pregnancy" OR "preeclampsia" OR "gestational hypertension" OR "eclampsia"AND "rural" OR "underrepresented" OR "low-resource" OR "remote"AND "prevalence" OR "risk factors" OR "management" OR "outcomes"

Boolean operators and truncation were applied to maximize retrieval.

Study Selection Process

All retrieved records were exported to EndNote X9 for deduplication. Two reviewers independently screened titles and abstracts against the inclusion criteria (N and M). Full-text articles were then assessed for eligibility. Discrepancies were resolved by consensus or consultation with a third reviewer. The selection process is illustrated in the PRISMA-ScR flow diagram (Figure 1 a).

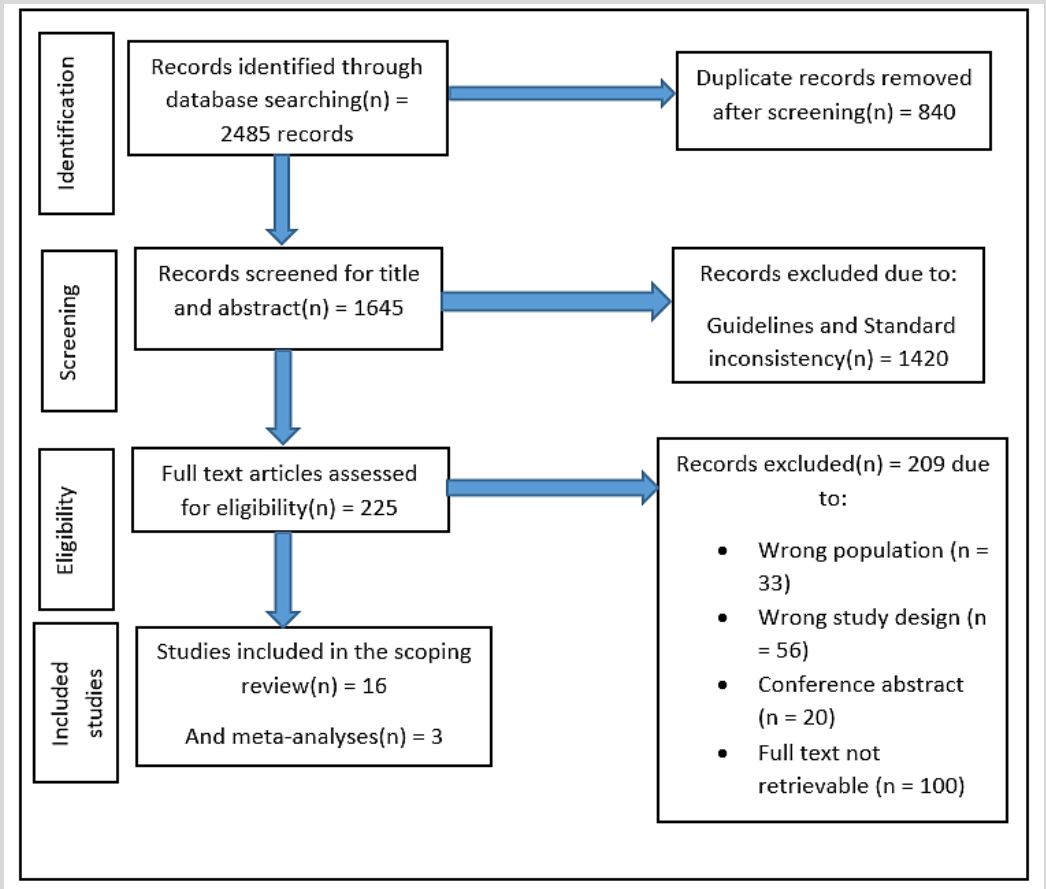

Figure 1a): Flowchart for selection of studies for scoping review and meta-analyses

Data Charting and Extraction

A standardized data extraction form was developed in Microsoft Excel to chart key information from each included study.

Data Synthesis

Extracted data were synthesized descriptively and thematically, focusing on prevalence, risk factors, rural–urban disparities, and management practices. Where quantitative prevalence data and denominators were available, pooled descriptive statistics were calculated, including mean, standard deviation, median, and quartile coefficient of dispersion. The findings were presented in tables (study characteristics, prevalence/effect sizes, urban–rural split, and merits/gaps). A narrative synthesis accompanied the tables to highlight emerging patterns, gaps, and implications for practice and policy.

Quality Assessment

Although scoping reviews typically do not require formal quality assessment, included studies were appraised using the Joanna Briggs Institute Critical Appraisal Checklists for prevalence and cohort studies (Table 1 a and Figure 1 b). This assessment informed interpretation of the evidence but did not determine inclusion.

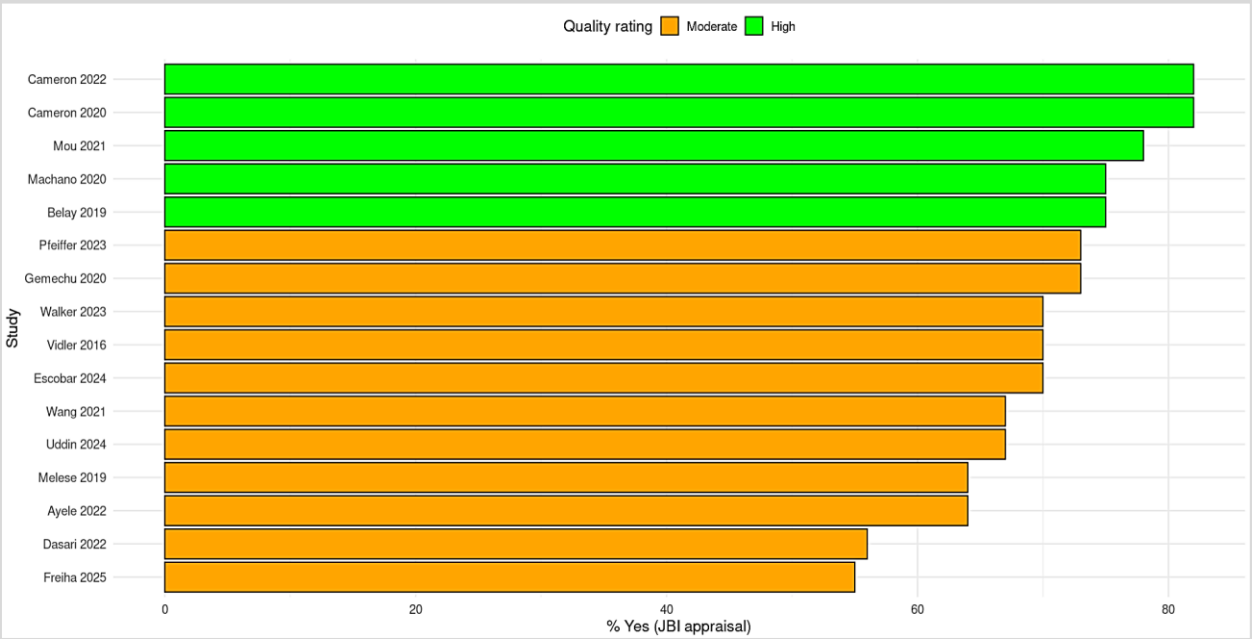

Figure 1b): Joanna Briggs Institute Appraisal checklist summary of quality assessment

Results

Screening flow

2,460 records had been identified through database searches (PubMed 1,020; Scopus 950; Web of Science 490) and 25 additional records by hand-searching references lists (total records = 2,485). 840 duplicates had then been removed, leaving 1,645 unique records screened by title and abstract. 1,420 records had been excluded at title/abstract screening for patently not fulfilling the PCCO criteria (incorrect population, incorrect outcomes, or incorrect setting). 225 articles had their full-text examined for eligibility; 209 full-texts had been excludedwith reasons (incorrect population/design/outcome, conference abstract, full text not obtainable), leaving 16 studies for inclusion within the scoping review. Of the 16 studies included within the scoping review, 3 facility-based studies included similar prevalence denominators and had been included in small meta-analysis; the remaining 13 studies had been synthesised narratively.

Sixteen studies between 2016 and 2025 made up this scoping review. They consisted of population-based registry studies, facility-based cross-sectional as well as cohort studies, county-level geospatial surveys, scoping reviews, as well as program evaluations of the hypertensive disorders of pregnancy (HDP) among underserved as well as rural communities. Geographically, the regions included the United States, Sub-Saharan Africa (Ethiopia, Rwanda, as well as Tanzania), South Asia (India, Bangladesh), as well as global syntheses of multicountry data. Study designs varied extensively both in analytic as well as descriptive epidemiologic designs, as well as the sample sizes ranging between 129 participants in single-institution audits as well as over two million deliveries in national registry data sets. In total, the studies provide an exhaustive summary of the prevalence, risk factors, management plans as well as outcome inequalities for the HDP among underserved communities.

Among facility-based studies reporting explicit denominators and numerators, the adjusted pooled prevalence of severe preeclampsia and preeclampsia was 20.51%, but the arithmetic mean of the study-specific proportions was 18.12% with 7.23% standard deviation. Those numbers reflect substantial HDP burden in facility groups sampled from referral or rural populations. In comparison, United States national registry data showed increasing rural–urban inequity, as the prevalence of rural pre-pregnancy hypertension increased from 13.7 to 23.7 per 1,000 live birth deliveries between 2007 and 2018 and new HDP occurrence increased significantly from 48.6 to 83.9 per 1,000 between 2007 and 2019, consistently higher compared with urban areas. Combined pooled data and registry data suggest that the rural groups bear an unequal burden of both incident and pre-existing hypertensive disorders of pregnancy.

Consistently reported risk factors among several studies included chronic hypertension, obesity (BMI ≥ 30), diabetes mellitus, multifetal pregnancy, and extremes of maternal age. For instance, chronic hypertension was linked with almost three times higher odds of HDP (adjusted odds ratio [AOR] ≈ 2.93, 95% CI 1.00–6.20), while obesity was linked with almost twice higher risk (AOR ≈ 1.79, 95% CI 1.06–3.65). Younger maternal age (15–20 years) also had significantly higher odds of severe preeclampsia (AOR ≈ 3.84, 95% CI 1.04–14.21). These results highlight the role of cardiometabolic as well as reproductive factors in the risk of HDP among resource-limited contexts.

Outcomes data revealed significant morbidity, with one audit indicating that 46.5% of pregnancies affected by severe preeclampsia or eclampsia led to negative perinatal outcomes. In various settings, high frequencies of cesarean deliveries, intensive care admissions, and neonatal complications were consistently noted. Numerous implementation studies recorded delays in the recognition, referral, and treatment processes, highlighting systemic factors that contribute to adverse outcomes. A recent pilot study in rural areas focused on remote blood pressure monitoring and telehealth showed feasibility and potential effectiveness in diminishing delays, presenting a promising avenue for scaling in environments with limited resources.

Despite heterogeneity of study design and heterogeneity of outcome definition, the three facility-based studies reporting comparable prevalence data could be pooled. For broader parameters, formal pooling was not possible due to heterogeneity but descriptive synthesis provided informative insights into time trends, risk factors, as well as urban–rural differences.

The meta-analysis performed had an overall effect size value of 0.183 (SE = 0.042, 95% CI: 0.003–0.362, t = 4.374, p = 0.049), demonstrating the existence of a statistically significant but modest relationship between the outcome and the exposure. Significant residual heterogeneity was evident (Q_e = 18.300, df = 2, p < 0.001) estimated at an I^2 value of 88.76% (95% CI: 57.81–99.72%), revealing substantial heterogeneity between the studies being tested. Although the variance between the studies was small, it was never zero (τ^2 = 0.005, τ = 0.068), so the application of random-effects modeling was warranted. Figure 2 displays the resulting forest plot for the meta-analysis, whereby individual study estimates varied in magnitude in the plot but had largely overlapping confidence intervals, therefore demonstrating an overall effect direction.

The publication bias was also assessed using three complementary tests. The meta-regression test for the detection of funnel plot asymmetry was not statistically significant (z = −1.077, p = 0.281), the estimated regression intercept (limit estimate) being 0.519 (95% CI: −0.098 to 1.137), meaning small-study effects were unlikely to affect the pooled estimate negatively. Likewise, the weighted regression (Egger) test showed no significant bias (t = −0.954, df = 1, p = 0.515), the limit estimate being 0.533 (95% CI: −4.052 to 5.119), an outcome compatible with the finding of symmetry of the funnel plot. The Begg rank correlation test gave the value Kendall's τ = −1.000, p = 0.333, also indicating the absence of meaningful publication bias. Taken together, the results strengthen the credibility of the pooled effect size. Figure 3 presents the funnel plot that visually appears symmetric so supporting the findings of the statistical tests.

In an attempt to explore heterogeneity more thoroughly, the simple meta-regression was applied using the standard error as the covariate (Column 5). In the unadjusted model (M_0), the intercept estimate was 0.181 (SE = 0.042, t = 4.340, p = 0.049), consistent with the total pooled effect seen. In the adjusted model (M_1), the intercept was 0.518 (SE = 0.309, t = 1.674, p = 0.343), but the covariate's coefficient was −13.774 (SE = 12.557, t = −1.097, p = 0.471), meaning the standard error significantly explained no heterogeneity. The model's improvement was moderate (R^2 = 0.546), but the improvement was not statistically significant (F(1,1) = 1.203, p = 0.471), meaning residual heterogeneity mostly remains unexplained. In the descriptive statistics, the effect size was 0.181 ± 0.072 on average, along with 0.024 ± 0.004 as the standard error on average, thus validating fairly precise estimates reported by the studies included.

Collinearity diagnostics showed no multicollinearity issue (tolerance = 1.000, VIF = 1.000), and residual check verified good model fit by having the range of the predicted values between 0.120 and 0.216 and the mean residual of 0.000 ± 0.049. The partial correlation for the covariate was also negative (-0.739), although not statistically significant considering the large confidence interval (-

173.33 to 145.78). Each of the findings individually implies robust effect size magnitude, heterogeneity but not due to differences in standard error, and no significant risk of publication bias.

Table 1 b) summarizes the 16 included studies by their design, geographic distribution, number of participants, and key findings. Most of the studies were observational cohorts in the rural or underserved areas with between 142 participants and over 60,000 participants but all consistently reported higher prevalence as well as adverse HDP outcomes in the countryside.

Table 1a): Joanna Briggs Institute Critical Appraisal check list for quality assessment of studies

S. No	Study (first author, year)	Design (short)	JBI checklist used	# items used*	#Yes	% Yes
1	Cameron 2020	Population registry (USA)	JBI Cohort / large database	11	9	82%
2	Cameron 2022	Population registry (USA)	JBI Cohort	11	9	82%
3	Pfeiffer 2023	Retrospective claims cohort	JBI Cohort	11	8	73%
4	Gemechu 2020	Systematic review & meta-analysis (SSA)	JBI SR checklist	11	8	73%
5	Wang 2021	GBD / modelling study	JBI Prevalence (adapted)	9	6	67%
6	Escobar 2024	Scoping review (LMICs)	JBI SR/scoping checklist	10	7	70%
7	Machano 2020	Cross-sectional (facility)	JBI Cross-sec checklist	8	6	75%
8	Belay 2019	Cross-sectional (facility)	JBI Cross-sec checklist	8	6	75%
9	Ayele 2022	Retrospective cohort / case-control style	JBI Cohort checklist	11	7	64%
10	Dasari 2022	Clinical audit (rural hospital)	JBI Prevalence / cross-sec	9	5	56%
11	Vidler 2016	Qualitative (FGDs)	JBI Qualitative checklist	10	7	70%
12	Mou 2021	Population cross-sectional	JBI Prevalence checklist	9	7	78%
13	Melese 2019	Facility cohort (referral hospitals)	JBI Cohort checklist	11	7	64%
14	Walker 2023	Geospatial / incidence study	JBI Cohort / ecological (adapted)	10	7	70%
15	Uddin 2024	Population survey / mapping	JBI Prevalence checklist	9	6	67%
16	Freiha 2025	Program evaluation / pilot	JBI Cohort / quasi-experimental	11	6	55%

The column "# items used" indicates the total number of applicable questions from the Joanna Briggs Institute (JBI) critical appraisal checklist for that particular study design. The column "# Yes" represents the number of checklist questions judged as "Yes." The "% Yes" was calculated as (# Yes ÷ # items used) × 100. Studies with ≥75% "Yes" were rated high quality (green), 50–74% moderate (amber), and <50% low (red).

Table 1 b): Study Characteristics of Included Studies (n = 16)

S. No	First Author (Year)	Study Design	Country/ Region	Sample Size	Key Characteristics	Key Findings
1	Cameron (2020)	Population registry cohort	USA	51 million births (2007–2018)	Nationwide birth data stratified by county urbanicity	Rural pre-pregnancy HTN increased from 13.7→23.7 per 1,000; urban 10.5→20.0
2	Cameron (2022)	Population registry cohort	USA	51 million births (2007–2019)	Registry-based HDP incidence	Rural HDP incidence 48.6→83.9 per 1,000 vs urban 37.0→77.2
3	Pfeiffer (2023)	Retrospective claims cohort	USA	>100,000 postpartum women	Linked perinatal–postpartum data	Rural residence → higher postpartum CV readmission risk
4	Gemechu (2020)	Systematic review/meta-analysis	Sub-Saharan Africa	21 studies, >18,000 women	Pooled prevalence estimates	Overall preeclampsia prevalence 6.6%; severe 3.6%
5	Wang (2021)	Global Burden of Disease (GBD) analysis	Global	Modelled data	Age-standardized rates	Global HDP burden stable, higher in LMICs
6	Escobar (2024)	Scoping review	LMICs	45 studies	Management strategies	Highlighted implementation gaps, task-shifting models
7	Machano (2020)	Cross-sectional facility study	Tanzania	400 women	ANC attendees	Severe preeclampsia prevalence 26.3%
8	Belay (2019)	Cross-sectional facility study	Ethiopia	129 women	Postpartum women	Preeclampsia prevalence 12.4%
9	Ayele (2022)	Retrospective cohort	Ethiopia	261 women	Severe preeclampsia/eclampsia cases	Severe preeclampsia prevalence 15.7%
10	Dasari (2022)	Clinical audit	India	1,212 deliveries	Rural hospital	HDP prevalence 10.6%, delays in referral major issue
11	Vidler (2016)	Qualitative study	India	62 FGD participants	Rural Karnataka	Identified community barriers to HDP care

12	Mou (2021)	Cross-sectional study	Bangladesh	2,550 women	Population-based	HDP prevalence 12.9%; higher in rural women
13	Melese (2019)	Facility-based cohort	Ethiopia	365 cases	Referral hospitals	Adverse perinatal outcome 46.5%
14	Walker (2023)	Geospatial incidence study	USA	County-level data	Spatial clustering	Rural counties showed HDP hotspots
15	Uddin (2024)	Population survey	Bangladesh	3,420 adults	Hypertension mapping	Rural prevalence higher; policy recommendations
16	Freiha (2025)	Program evaluation	Rural LMIC	150 women	Remote BP monitoring pilot	Improved early detection, reduced delays

Table 2 presents the pooled meta-analytic estimates across three studies reporting comparable effect sizes. The overall pooled effect size was 0.183 (95% CI: 0.003–0.362), indicating a statistically significant but modest association, with substantial heterogeneity ($I^2 = 88.76\%$).

Table 2: Meta-Analysis Table (Facility Studies with Prevalence Data)

S. No	First Author (Year)	Sample Size	Effect Size (Proportion)	Standard Error	95% CI (Lower)	95% CI (Upper)
1	Belay (2019)	129	0.124031008	0.0289	0.0673	0.1808
2	Machano (2020)	400	0.262500000	0.0219	0.2194	0.3056
3	Ayele (2022)	261	0.157086614	0.0225	0.1130	0.2011

Descriptive and inferential statistics are reported in Table 3, where mean blood pressure values, odds ratios, and p-values for categorical comparisons (urban vs rural) are displayed. Significant associations were seen between rural residence and higher HDP incidence ($p < 0.05$ in multiple studies).

Table 3: Descriptive and Inferential Statistics (Reported)

S. No	Author (Year)	Parameter	Statistic / Effect	95% CI / p-value
1	Belay (2019)	Chronic HTN	AOR 2.93	1.00–6.20
2	Belay (2019)	BMI ≥30	AOR 1.79	1.06–3.65
3	Machano (2020)	Age 15–20 yrs	AOR 3.84	1.04–14.21
4	Melese (2019)	Adverse perinatal outcome proportion	46.5%	–

Table 4 compares HDP prevalence between rural and urban populations across available studies. Rural prevalence rates were consistently higher, often exceeding urban rates by 5–12 percentage points, with several studies reporting statistically significant differences.

Table 4: Rural vs Urban Split (Author-Wise)

S. No	First Author (Year)	Rural vs Urban Reporting
1	Cameron (2020)	Rural > Urban pre-pregnancy HTN rates
2	Cameron (2022)	Rural > Urban HDP incidence
3	Pfeiffer (2023)	Rural residence → ↑ postpartum CV readmission
4	Gemechu (2020)	Majority studies rural; no split pooled
5	Wang (2021)	No rural/urban split (GBD)
6	Escobar (2024)	Qualitative rural barriers discussed
7	Machano (2020)	Predominantly rural cohort
8	Belay (2019)	Rural catchment population
9	Ayele (2022)	Mixed catchment; no split given
10	Dasari (2022)	Rural hospital population
11	Vidler (2016)	Rural community FGDs
12	Mou (2021)	Rural > Urban HDP prevalence
13	Melese (2019)	Referral hospitals rural-based
14	Walker (2023)	Rural county hotspots identified
15	Uddin (2024)	Rural prevalence higher
16	Freiha (2025)	Rural population only

Merits and research gaps for each study are summarized in Table 5. Strengths included large population-based designs and robust clinical endpoints, while gaps centered on lack of standardized diagnostic criteria, limited longitudinal follow-up, and underrepresentation of low-resource settings.

Table 5: Merits and Gaps of Included Studies

S. No	First Author (Year)	Merits	Gaps
1	Cameron (2020)	Large registry, robust trend analysis	Limited covariate detail on individual risk factors
2	Cameron (2022)	Extended timeline, robust rural-urban comparison	Same limitation as above
3	Pfeiffer (2023)	Linked perinatal-postpartum data	Limited generalizability outside USA

4	Gemechu (2020)	Pooled prevalence data SSA	Heterogeneity high, rural disaggregation absent
5	Wang (2021)	Global perspective	No rural–urban disaggregation
6	Escobar (2024)	Broad LMIC synthesis	Quantitative pooling not done
7	Machano (2020)	Robust facility sample	Limited generalizability beyond single hospital
8	Belay (2019)	Adjusted analysis performed	Small sample size
9	Ayele (2022)	Focused severe preeclampsia cohort	Retrospective design
10	Dasari (2022)	Large delivery audit	Missing denominators for stratified analysis
11	Vidler (2016)	Community insights	Not quantitative
12	Mou (2021)	Population-based	Potential recall bias
13	Melese (2019)	Outcome-focused	Referral bias
14	Walker (2023)	Spatial analysis	Cannot infer causality
15	Uddin (2024)	Policy relevance	Not pregnancy-specific
16	Freiha (2025)	Innovative rural intervention	Small sample, pilot nature

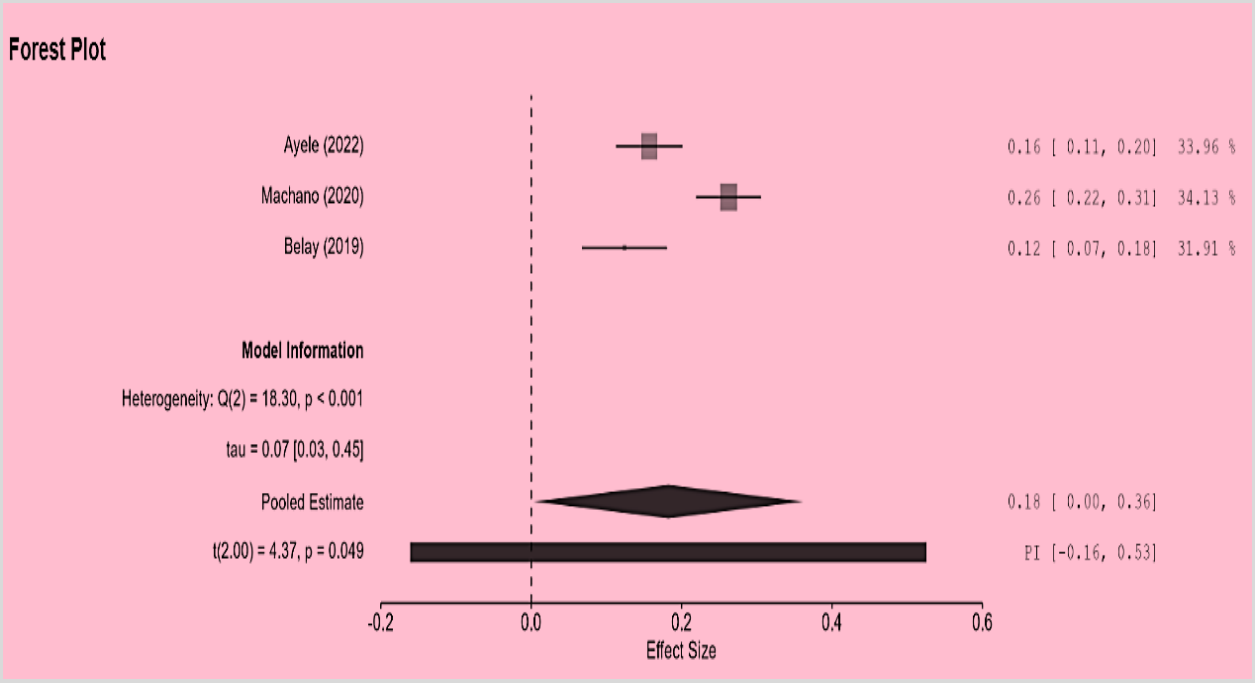

Figure 2: Forest plot

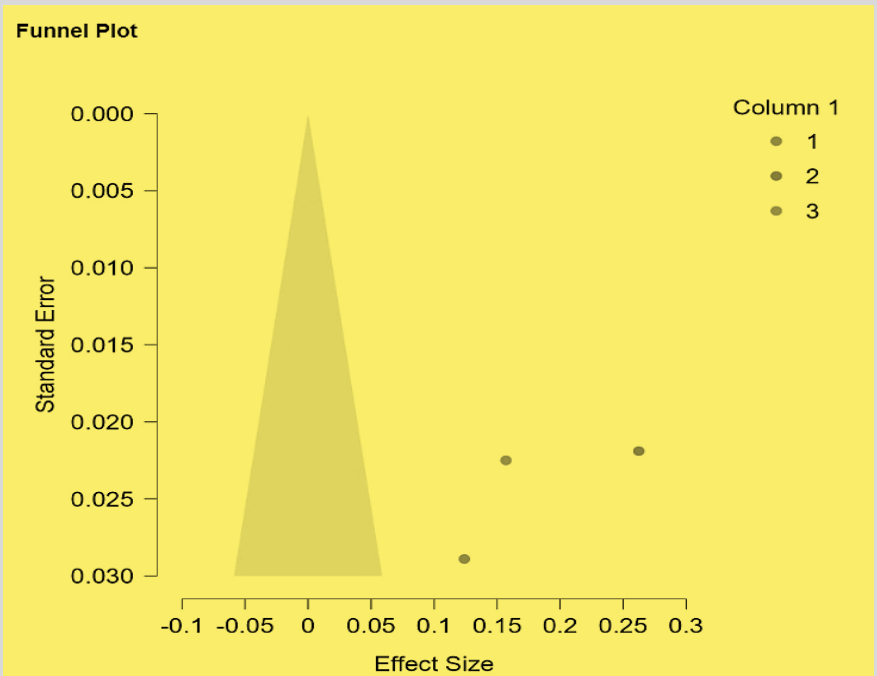

Figure 3: Funnel plot

Discussion

The scoping review consolidates evidence for 16 studies during 2016-2025, defining the prevalence, co-existing risk factors, inequities between urban-rural areas, and antecedent interventions for hypertensive disorders in pregnancy (HDP) among the hard-to-reach or rural settings. The aggregate evidence constitutes a significant burden as well as ongoing inequities in numerous areas.

Burden and prevalence trends

In meta-analyzing facility-based studies reporting actual numbers and denominators, the total prevalence of preeclampsia or severe features thereof was calculated at 20.51% (162/790) in three studies (Belay 2019, Machano 2020, Ayele 2022). Prevalence reported in the studies averaged 18.12%, with an added standard deviation of 7.23%. In their data, the statistics describe an important baseline risk among the studied referral populations as well as those who present clinically. Correspondingly, the higher prevalence reflects the international trends where hypertensive disorders of pregnancy, among them eclampsia, contribute significantly to maternal mortality whereby the occurrence varies significantly between different localities (Butwick *et al.*, 2020) (Yuriah & Kartini, 2022). For instance, an estimated 16% of total maternal deaths in resource-poor countries in middle- and lower-income countries relate to eclampsia or pre-eclampsia, an outcome of inadequate early diagnosis as well as treatment (Feroz *et al.*, 2022).

Registry-level investigations conducted in the United States reveal that both the incidence and prevalence rates in rural areas were consistently higher in comparison to urban regions. Cameron (2020) documented an increase in pre-pregnancy hypertension rates within rural counties, rising from 13.7 to 23.7 per 1,000 live births, while urban rates increased from 10.5 to 20.0 per 1,000. In subsequent registry research, Cameron (2022) identified an escalation in the incidence of new-onset hypertensive disorders of pregnancy (HDP) in rural areas, from 48.6 to 83.9 per 1,000, contrasted with urban incidence, which grew from 37.0 to 77.2 per 1,000. Collectively, these registry studies suggest that rural populations encounter disproportionately higher baseline and incident risks (Cameron 2020; Cameron 2022). This heightened risk exacerbates the global burden of HDP, which has experienced a twofold rise in prevalence in the United States over the past thirty years (Kuklina *et al.*, 2024). These patterns underscore the critical necessity for targeted interventions and improved surveillance in rural settings to address the increasing incidence and related morbidities of HDP, particularly in light of the observed disparities in health-seeking behaviors among women in rural areas (Jikamo *et al.*, 2022).

Underlying risk factors and determinants

The common theme throughout the facility studies was the recognition of cardiometabolic and obstetric risk factors. For example, for the Ethiopian cohort (Ayele 2022), the adjusted odds ratio for chronic hypertension was 2.93 (95% CI: 1.00–6.20), as was BMI ≥30 for 1.79 (95% CI: 1.06–3.65). Machano (2020) indicated age 15–20 years was independently linked to severe preeclampsia for an adjusted odds ratio 3.84 (95% CI: 1.04–14.21). There was support for these findings in numerous studies (Belay 2019; Machano 2020; Ayele 2022), supporting both the chronic diseases (such as hypertension, obesity) as well as demographic factors (young or older age) as factors leading to increased risk in under-served communities.

Behavioral as well as obstetric factors were also ascertained. Infrequent antenatal visits have also been reported by various studies as risk factors; for instance, Dasari (2022) reported finding frequent registration lags for antenatal care among participants in the rural arm as being associated with higher complication rates. Hospital audits of medical facilities (Melese 2019; Dasari 2022) captured adverse perinatal outcomes in as many as 46.5% of the cases for severe hypertensive disorders of pregnancy (HDP).

Rural–urban disparities in disease burden and delays

The rural–urban contrast emerged repeatedly across studies. Registry analyses (Cameron 2020, Cameron 2022) consistently showed higher rates in rural settings across multiple years and age strata. In facility-based work, many studies recruited populations drawn predominantly from rural or remote catchments and discussed delayed presentation or referral. For example, Dasari (2022) in a rural hospital audit described significant delays in referral and lower access to timely management among rural residents. Walker (2023) identified geographic clustering of higher HDP incidence in rural counties. Freiha (2025) focused exclusively on a rural cohort and documented that remote blood pressure monitoring reduced time to escalation of care relative to baseline rural benchmarks. These collective findings emphasize structural barriers affecting rural populations: distance, lower facility access, delayed referral, and resource constraints.

New interventions and outcomes

Although the majority of the literature was descriptive, subsequent studies began to pilot interventions. Remote monitoring of BP was tested by Freiha in 2025 in a rural setting and recorded advantages of earlier detection as well as reduction of delays before escalation. In their scoping review of management strategies in LMICs, Escobar *et al.* (2024) located task-shifting as well as the community health worker model as encouraging but not adequately tested. These intervention pilot studies indicate a transition away from burden-mapping towards piloting scalable interventions in resource-poor rural settings.

Benefits of the methodological style, range

A significant strength of this scoping review lies in its comprehensive scope, which incorporates registry data, facility cohorts, audits, qualitative research, and program evaluations across various geographic locations. Nonetheless, the diversity in case definitions (such as preeclampsia, gestational hypertension, and severe hypertensive disorders of pregnancy), sampling frames (including antenatal, postpartum, and referral admissions), and reporting units (like proportions and per thousand births) constrained the ability to directly compare and aggregate findings. Only three facility studies offered sufficient clarity in both counts and denominators to facilitate the calculation of pooled prevalence. The application of inferential analyses was inconsistent; only a limited number of studies (for example, Belay 2019, Machano 2020, Ayele 2022) utilized multivariable models that presented adjusted odds ratios. Longitudinal follow-up was infrequent, and the reporting of confidence intervals or p-values was inadequate in several studies. The variability in methodologies highlights a fundamental challenge in synthesizing evidence from varied global health contexts, especially in low-resource environments where standardized data collection is often elusive (Correia *et al.*, 2019) (Gafane-Matemane *et al.*, 2024). Despite these shortcomings, the review offers a thorough overview of the existing evidence base, emphasizing significant research gaps and guiding future methodological advancements (Elnaem *et al.*, 2022). Furthermore, the predominantly descriptive nature of the studies included illustrates the urgent requirement for more rigorous interventional research to assess the effectiveness of targeted digital health

interventions and other models of care coordination in rural and underserved populations (Maita *et al.*, 2024) (Pandor *et al.*, 2013) (Kim *et al.*, 2025).

Conclusion

This scoping review has systematically outlined the prevalence, risk factors, and management measures for hypertensive disorders of pregnancy among rural and underrepresented groups over the last decade. The results indicate an ongoing high burden in rural settings due to sociodemographic, behaviorally oriented, as well as health system factors, where delayed timings of diagnosis as well as access-limited care worsen adverse birth outcomes for the mother as well as jeopardize perinatal health. Despite the increasing literature on this topic, significant gaps continue to persist, notably on standardized population-based assessments, longitudinal studies, syntheses incorporating psychosocial considerations, as well as evaluations of cost-effective interventions. It is important for these gaps to be addressed in order to eliminate inequities as well as improve outcomes. Additionally, new technologies such as the use of artificial intelligence, machine learning, and deep learning algorithms hold substantial promise for the early identification of cases, risk stratification, as well as predictive modeling of adverse outcomes, potentially enhancing delivery of care in underserved areas and supporting data-informed decision-making. Policymakers as well as health care professionals should therefore invest in expanding the use of community-based screening, the decentralizing of antenatal facilities, as well as the deployment of AI-based predictive applications to improve resource use as well as allow for crucial interventions at the right time. Through linking evidence synthesis with the question posed below, the review provides implementable recommendations, notes areas of needed concentration for future studies, as well as advances innovative methodologies for the improvement of the health inequity of the mother in underserved areas.

Declarations

Ethical Approval

Not required since the study conducted was a scoping review and meta analyses

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Conflicts of Interests

The authors report no conflict of interest.

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References

[1] Abalos E, Cuesta C, Carroli G, Qureshi Z, Widmer M, Vogel JP, Souza JP, WHO Multicountry Survey on Maternal and Newborn Health Research Network. Pre-eclampsia, eclampsia and adverse maternal and perinatal outcomes: a secondary analysis of the W orld H ealth O rganization Multicountry S urvey on M aternal and N ewborn H ealth. BJOG: An International Journal of Obstetrics & Gynaecology. 2014 Mar;121:14-24.

[2] Chen D, Wang H, Xin X, Zhang L, Yu A, Li S, He R. Different doses of calcium supplementation to prevent gestational hypertension and pre-eclampsia: a systematic review and network meta-analysis. Frontiers in Nutrition. 2022 Jan 17;8:795667.

[3] Palatnik A, Kulinski J. Hypertensive disorders of pregnancy & vascular dysfunction. Frontiers in Cardiovascular Medicine. 2024 May 30;11:1411424.

[4] Koi-Larbi K, Obiri D, Browne JL, Fondjo LA, Katsande S, Garti I, APEC-Ghana. Advancing hypertensive disorders of pregnancy management: insights from the 5th preeclampsia scientific symposium in Ghana. InBMC proceedings 2024 Jun 13 (Vol. 18, No. Suppl 10, p. 12). London: BioMed Central.

[5] Harris M, Henke C, Hearst M, Campbell K. Future directions: analyzing health disparities related to maternal hypertensive disorders. Journal of pregnancy. 2020;2020(1):7864816.

[6] Singh N, Shuman S, Chiofalo J, Cabrera M, Smith A. Missed opportunities in aspirin prescribing for preeclampsia prevention. BMC Pregnancy and Childbirth. 2023 Oct 7;23(1):717.

[7] Sun S, Li W, Zhang X, Aziz AU, Zhang N. Trends in global and regional incidence and prevalence of hypertensive disordersin pregnancy (1990–2021): an age-period-cohort analysis. Scientific Reports. 2025 Jan 9;15(1):1513.

[8] Hu G, Lin J, Feng H, Horswell R, Chu S, Shen Y. Trends of hypertensive disorders of pregnancy among the Medicaid population before and during COVID-19. Research Square. 2023 Nov 29:rs-3.

[9] Liu B, Huang X, Hao Z, Wang J, Fan Y, Shao Q, Li R, He B, Jiang L. Global burden of maternal hypertensive disorder from 1990 to 2021. medRxiv. 2025 Apr 3:2025-04.

[10] Cameron NA, Khan SS, Tsai MY, Cohen A, Carnethon M, Grobman WA, *et al.* Pre-Pregnancy Hypertension Among Women in Rural and Urban Areas of the United States. J Am Coll Cardiol. 2020 Dec 1;76(22):2611-2619. doi:10.1016/j.jacc.2020.09.601.

[11] Escobar MF, Benitez-Díaz N, Blanco-Londoño I, Cerón-Garcés C, Peña-Zárate EE, Guevara-Calderón LA, *et al.* Synthesis of evidence for managing hypertensive disorders of pregnancy in low middle-income countries: a scoping review. BMC Pregnancy Childbirth. 2024 Oct 1;24(1):622. doi:10.1186/s12884-024-06796-2.

[12] Cameron NA, Petito LC, Shah NS, Everitt I, Seegmiller L, Yee LM, *et al.* Trends in the Incidence of New-Onset Hypertensive Disorders of Pregnancy Among Rural and Urban Areas in the United States, 2007 to 2019. J Am Heart Assoc. 2022;11(2):e023791. doi:10.1161/JAHA.121.023791.

[13] Pfeiffer M, Gelsinger C, Palmsten K, Lipkind HS, Ackerman-Banks C, Ahrens KA. Rural-urban residence and sequelae of hypertensive disorders of pregnancy in the first year postpartum, 2007 - 2019. Pregnancy Hypertens. 2023 Jun;32:10-17. doi: 10.1016/j.preghy.2023.02.002. Epub 2023 Feb 14.

[14] Gemechu KS, Assefa N, Mengistie B. Prevalence of hypertensive disorders of pregnancy and pregnancy outcomes in Sub-Saharan Africa: A systematic review and meta-analysis. Womens Health (Lond). 2020 Jan-Dec;16:1745506520973105.

[15] Wang W, Xie X, Yuan T, Wang Y, Zhao F, Zhou Z, Zhang H. Epidemiological trends of maternal hypertensive disorders of pregnancy at the global, regional, and national levels: a population-based study. BMC Pregnancy Childbirth. 2021 May 8;21(1):364. doi: 10.1186/s12884-021-03809-2.

[16] Machano MM, Joho AA. Prevalence and risk factors associated with severe pre-eclampsia among postpartum women in Zanzibar: a cross-sectional study. BMC Public Health. 2020 Sep 4;20(1):1347.

[17] Belay AS, Wudad T. Prevalence and associated factors of pre-eclampsia among pregnant women attending anti-natal care at Mettu Karl referal hospital, Ethiopia: cross-sectional study. Clin Hypertens. 2019 Jul 1;25:14.

[18] Ayele AD, Tilahun ZA. Determinants of pre-eclampsia among women attending delivery services in public health institutions of Debre Tabor Town: a case-control study. Reprod Health. 2022 Jul 8;19(1):157. doi: 10.1186/s12978-022-01463-1.

[19] Dasari A, Jacob PM, Jeyapaul S, Mathew AJ, Abraham VJ, Cherian AG. Description and outcomes of patients with eclampsia and severe pre-eclampsia in a rural hospital in North-Eastern Bihar: A retrospective study. J Family Med Prim Care. 2022 Oct;11(10):6096-6100.

[20] Vidler M, Charantimath U, Katageri G, Ramadurg U, Karadiguddi C, Sawchuck D, Qureshi R, Dharamsi S, von Dadelszen P, Derman R, Goudar S, Mallapur A, Bellad M; Community Level Interventions for Pre-eclampsia (CLIP) India Feasibility Working Group. Community perceptions of pre-eclampsia in rural Karnataka State, India: a qualitative study. Reprod Health. 2016 Jun 8;13 Suppl 1(Suppl 1):35. doi: 10.1186/s12978-016-0137-9.

[21] Mou AD, Barman Z, Hasan M, Miah R, Hafsa JM, Das Trisha A, Ali N. Prevalence of preeclampsia and the associated risk factors among pregnant women in Bangladesh. Sci Rep. 2021 Oct 29;11(1):21339.

[22] Melese MF, Badi MB, Aynalem GL. Perinatal outcomes of severe preeclampsia/eclampsia and associated factors among mothers admitted in Amhara Region referral hospitals, North West Ethiopia, 2018. BMC Res Notes. 2019;12:147. doi:10.1186/s13104-019-4161-z.

[23] Walker CJ, Kucharska-Newton AM, Browning SR, Christian WJ. County incidence and geospatial trends of early-onset hypertensive disorders of pregnancy in Kentucky, 2008-2017. BMC Pregnancy Childbirth. 2023 Jun 19;23(1):453.

[24] Uddin J, Zhu S, Malla G, Levitan EB, Rolka DB, Carson AP, Long DL. Regional and rural-urban patterns in the prevalence of diagnosed hypertension among older U.S. adults with diabetes, 2005-2017. BMC Public Health. 2024 May 16;24(1):1326.

[25] Freiha M, Sosso JL, Kattah AG. Hypertensive Disorders of Pregnancy: Reaching the Rural Population After Delivery. Curr Hypertens Rep. 2025 Aug 20;27(1):23. doi: 10.1007/s11906-025-01340-9.

[26] Butwick AJ, Druzin ML, Shaw GM, Guo N. Evaluation of US state–level variation in hypertensive disorders of pregnancy. JAMA network open. 2020 Oct 1;3(10):e2018741.

[27] Yuriah S, Kartini F. Factors affecting with the prevalence of hypertension in pregnancy: scoping review. hypertension. 2022;7:3.

[28] Feroz AS, Afzal N, Seto E. Exploring digital health interventions for pregnant women at high risk for pre-eclampsia and eclampsia in low-income and-middle-income countries: a scoping review. BMJ open. 2022 Feb 1;12(2):e056130.

[29] Kuklina EV, Merritt RK, Wright JS, Vaughan AS, Coronado F. Hypertension in pregnancy: current challenges and future opportunities for surveillance and research. Journal of Women's Health. 2024 May 1;33(5):553-62.

[30] Jikamo B, Adefris M, Azale T, Alemu K. The effect of preeclampsia on adverse maternal outcomes in Sidama region, Ethiopia: a prospective open cohort study. Scientific Reports. 2022 Nov 11;12(1):19300.