Determinants of Pre-Eclampsia Among Pregnant Women Attending Antenatal Clinics in Primary Health Care Centers: A Systematic Review

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ABSTRACT

Pre-eclampsia is a hypertensive disorder of pregnancy constituting a leading cause of maternal and perinatal morbidity and mortality globally, with a disproportionate burden in low- and middle-income countries. Primary Health Care (PHC) centres are critical first-contact points for antenatal care in underserved communities, yet the determinants of pre-eclampsia among PHC attendees remain inadequately synthesized. The review aimed to synthesize the existing evidence on the prevalence and determinants of pre-eclampsia among pregnant women, with particular focus on factors identifiable at the PHC level in Nigeria and Osun State context. The study is a systematic review, which was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. Comprehensive searches were performed across PubMed/MEDLINE, Google Scholar, Scopus, African Journals Online (AJOL), and the Cochrane Library for studies published between January 2013 and March 2026. Observational studies (cross-sectional, case-control, and cohort designs) reporting prevalence estimates and/or determinants of pre-eclampsia among antenatal clinic attendees were included. Quality assessment was performed using the Newcastle-Ottawa Scale (NOS) adapted for cross-sectional studies. Narrative synthesis with thematic categorization of determinants was employed. The results revealed that 42 studies met the inclusion criteria and were included in the final synthesis.. The global pooled prevalence of pre-eclampsia was 4.43%, with significantly higher estimates in Sub-Saharan Africa (6.1–13%) and in Nigerian PHC/facility-based settings (4.51–18.9%). Six thematic domains of determinants emerged: biomedical/maternal health factors (obesity, chronic hypertension, diabetes, previous pre-eclampsia history), obstetric factors (nulliparity, multiple gestation, advanced maternal age), lifestyle factors (physical inactivity, poor dietary patterns, high salt intake), socioeconomic factors (low education, low income, financial barriers to care), health system/ANC utilization factors (late booking, inadequate ANC visits, limited screening capacity), and awareness/knowledge factors (pervasive poor knowledge across settings). Previous pre-eclampsia history was consistently the strongest predictor (OR range: 7–21.5), followed by chronic hypertension (OR: 2–18.7) and obesity (OR: 2.5–3.7). Social determinants including education and socioeconomic status were confirmed as essential but frequently overlooked in clinical risk assessments. In conclusion, the determinants of pre-eclampsia are multifactorial, spanning biomedical, obstetric, lifestyle, socioeconomic, and health system domains. PHC-level interventions including strengthened screening, structured health education, early ANC booking promotion, and social determinant-responsive care are critical for reducing the burden, particularly in underserved settings such as Ede South LGA, Osun State.

Keywords: pre-eclampsia, determinants, systematic review, antenatal care, primary health care, prevalence, Nigeria, Sub-Saharan Africa

INTRODUCTION

Preeclampsia is a serious hypertensive disorder of pregnancy characterized by new-onset hypertension (≥140/90 mmHg) and proteinuria (≥0.3 g/24 hours) typically developing after 20 weeks of gestation, presenting life-threatening risks to both mother and baby (WHO, 2025a). Globally, hypertensive disorders represent a

leading cause of maternal and perinatal morbidity and mortality, accounting for approximately 16% of maternal deaths equivalent to about 42,000 fatalities in 2023 (WHO, 2025a). Recent analysis of seventy studies involving over 2.4 million participants found a global prevalence of 4.43% (95% CI: 3.73–5.20), though rates vary based on whether ACOG (4.68%) or ISSHP (3.66%) diagnostic criteria are applied.

The burden of this condition is geographically skewed, with Sub-Saharan Africa disproportionately affected. In low- and middle-income countries, where access to and quality of antenatal care is often limited, preeclampsia and eclampsia alone contribute 10–15% of direct maternal deaths, representing 99% of such fatalities worldwide. In Nigeria, the burden of preeclampsia and its associated complications remains substantial. Kokori et al. (2024) reported a pooled prevalence of 4.51% for preeclampsia and 1.39% for eclampsia in Nigeria, with associated maternal and fetal mortality rates reaching 6.04% and 16.73%, respectively. These figures highlight a critical need for improved management strategies within the Nigerian healthcare system.

Limited access to healthcare, inadequate antenatal screening, and a lack of trained personnel contribute significantly to delayed diagnoses and poor clinical outcomes. While Primary Health Care (PHC) centres serve as the first point of antenatal contact for most pregnant women in underserved communities, the specific determinants of preeclampsia among PHC attendees remain inadequately synthesized in existing literature. Furthermore, previous reviews have focused largely on clinical and genetic risk factors, leaving a significant gap in the evaluation of social determinants necessary for effective prevention. The limited capacity of PHCs for definitive management often necessitates referrals to secondary facilities, which frequently results in delayed care and increased morbidity risk. Therefore, this systematic review aimed to synthesize the existing global and Nigerian evidence on:

(1) the prevalence of pre-eclampsia among antenatal care attendees;
(2) the level of awareness about pre-eclampsia among pregnant women;
(3) maternal health factors associated with pre-eclampsia;
(4) lifestyle factors associated with pre-eclampsia;
(5) socioeconomic factors predisposing to pre-eclampsia; and
(6) obstetric factors predisposing to pre-eclampsia with particular attention to factors identifiable and modifiable at the PHC level.

LITERATURE REVIEW

Epidemiology and Global Burden

Preeclampsia affects 3–8% of pregnancies worldwide and remains a primary contributor to maternal and neonatal morbidity and mortality (WHO, 2025). The early identification of risk factors and the evaluation of prognostic models are essential for improving clinical management and reducing complications. As a multisystem disorder characterized by new-onset hypertension and end-organ dysfunction after 20 weeks of gestation, its known risk factors include diabetes, kidney disease, obesity, and advanced maternal age. The burden is particularly high in Sub-Saharan Africa, where evidence regarding specific risk factors remains limited despite the high mortality rates. Pre-existing medical conditions are significant predictors; for instance, pregnant women with chronic hypertension are two to six times more likely to develop preeclampsia than those without such conditions.

Pathophysiology

Preeclampsia originates from abnormal placentation characterized by inadequate trophoblast invasion and incomplete remodeling of uterine spiral arteries. This leads to placental ischemia and oxidative stress (Onah et al., 2025; Torres-Torres et al., 2024). The prevailing two-stage model describes initial placental dysfunction followed by a maternal systemic syndrome involving endothelial dysfunction, vasoconstriction, and multi-organ injury (Kornacki, 2023). Clinically, this syndrome is defined by high blood pressure (≥140/90 mmHg) accompanied by at least one associated complication, such as proteinuria or maternal organ dysfunction.

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Key Determinant Domains

Contemporary literature recognizes that preeclampsia determinants span multiple domains beyond purely biomedical factors. A significant risk factor is a history of the condition in a previous pregnancy, which substantially increases the likelihood of recurrence. Furthermore, multifetal gestation is associated with a three- to four-fold increased risk. Pre-existing type I and type II diabetes mellitus also present elevated risks, with 10–20% of diabetic women developing the disorder. Beyond these clinical predictors, social and health system determinants are increasingly recognized as critical factors in the development and progression of the disease. The strength of these associations is typically categorized by the magnitude of the odds ratio (OR) or relative risk (RR), distinguishing between definite, probable, and possible associations to guide preventive strategies.

RESEARCH METHOD

Study Design and Protocol Registration

This systematic review was conducted following the PRISMA 2020 statement, which replaces the 2009 statement and includes new reporting guidance that reflects advances in methods to identify, select, appraise, and synthesise studies. PRISMA is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses, primarily focused on evaluating the effects of interventions but also usable for systematic reviews of other types of research, including evaluations of prevalence or prognosis. The review protocol was developed a priori to guide the analytical framework (Page et al., 2021).

Eligibility Criteria

Population: Pregnant women attending antenatal clinics in any healthcare setting (with particular interest in PHC and facility-based contexts).

Exposure/Determinants: Biomedical/maternal health factors, obstetric factors, lifestyle factors, socioeconomic factors, health system/ANC utilization factors, and knowledge/awareness-related factors.

Outcome: Pre-eclampsia, defined as new-onset hypertension (≥140/90 mmHg) with proteinuria (≥0.3 g/24h or ≥1+ on dipstick) after 20 weeks' gestation, or new-onset hypertension with evidence of maternal organ dysfunction, consistent with ISSHP or ACOG diagnostic criteria.

Study Design: Observational studies (cross-sectional, case-control, cohort) and systematic reviews/meta-analyses reporting prevalence estimates, risk factors, or determinants of pre-eclampsia.

Inclusion Criteria:
- Studies published in English between January 2013 and March 2026
- Studies with clearly defined diagnostic criteria for pre-eclampsia
- Studies reporting quantitative associations between at least one determinant and pre-eclampsia
- Sample size ≥100 participants (to ensure statistical precision)

Exclusion Criteria:
- Case reports, case series with <100 participants, editorials, letters, and commentaries
- Studies exclusively focused on gestational hypertension without differentiation of pre-eclampsia
- Studies conducted solely in vitro or in animal models
- Studies without clearly defined PE diagnostic criteria
- Duplicate publications

Information Sources and Search Strategy

Comprehensive electronic searches were conducted across five databases: PubMed/MEDLINE, Google Scholar, Scopus, African Journals Online (AJOL), and the Cochrane Library. The search was conducted from

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inception of each database through March 2026. Systematic searches employed a combination of Medical Subject Headings (MeSH) terms and free-text terms related to Pre-eclampsia, eclampsia, maternal and perinatal outcomes, pregnancy, and Nigeria, with Boolean operators ("AND" and "OR") used to refine the search strategy.

The search strategy combined the following terms: ("pre-eclampsia" OR "preeclampsia" OR "hypertensive disorders of pregnancy" OR "pregnancy-induced hypertension" OR "toxemia of pregnancy") AND ("determinants" OR "risk factors" OR "predictors" OR "associated factors") AND ("pregnant women" OR "antenatal" OR "prenatal care" OR "primary health care"). For Nigeria-specific searches, "Nigeria" OR "Osun State" OR "Sub-Saharan Africa" were added. Reference lists of identified systematic reviews and key primary studies were hand-searched for additional eligible studies.

Study Selection

Study selection followed a two-phase process. In Phase 1, titles and abstracts of all retrieved records were independently screened by two reviewers (OKK and OO) against the eligibility criteria. In Phase 2, full texts of potentially eligible studies were retrieved and independently assessed. Discrepancies at either stage were resolved through discussion and consensus. A PRISMA flow diagram was constructed to document the screening process.

Data Extraction

Data were extracted independently by both reviewers using a standardized data extraction form adapted from the Cochrane Collaboration template. Extracted data included: study characteristics (author, year, country, study design, setting, sample size); participant characteristics (mean age, gestational age range); pre-eclampsia diagnostic criteria used; prevalence estimates; determinants assessed and their effect measures (odds ratios, relative risks, with 95% confidence intervals and p-values); and key findings relevant to each thematic domain.

Quality Assessment

Among the tools available for evaluating observational studies, the Newcastle-Ottawa Scale (NOS) holds a prominent position and is widely applied in medical research, as a key step in systematic reviews is assessing study quality and risk of bias. The Newcastle-Ottawa Scale is a tool used for assessing the quality of non-randomized studies included in a systematic review, with each study judged on eight items categorized into three groups: selection of study groups, comparability, and outcome/exposure. For this review, the NOS adapted for cross-sectional studies was employed. Studies were scored with total scores categorized as: 13–16 points (high quality and low risk of bias), 9–12 points (moderate quality and moderate risk of bias), and <9 points (low quality and high risk of bias). Two reviewers independently assessed each study, with discrepancies resolved by consensus.

Data Synthesis

Given the anticipated heterogeneity in study designs, settings, diagnostic criteria, and determinant measurement methods, a narrative synthesis approach with thematic categorization was adopted. Determinants were organized into six thematic domains: (1) Prevalence patterns; (2) Awareness/knowledge; (3) Maternal health factors; (4) Lifestyle factors; (5) Socioeconomic factors; and (6) Obstetric factors. Within each domain, findings were synthesized by summarizing effect sizes, consistency of evidence across studies, and contextual relevance to PHC settings. Where systematic reviews/meta-analyses with pooled estimates were available, these were prioritized as the highest level of evidence.

RESULTS AND DISCUSSION
Study Selection and Characteristics

The systematic search identified 1,847 records across the five databases. After removing 412 duplicates, 1,435 records were screened by title and abstract, of which 189 were retrieved for full-text assessment. Following full-text review, 42 studies met the inclusion criteria and were included in the final synthesis. The included studies comprised 8 systematic reviews/meta-analyses, 18 cross-sectional studies, 10 case-control studies, and 6 cohort studies. Studies originated from Nigeria (n=14), other Sub-Saharan African countries (n=12), Asia (n=8), Europe/North America (n=5), and multi-country/global (n=3). Sample sizes ranged from 100 to >2.4 million participants.

Eleven studies conducted in Osun State met the inclusion criteria as represented on figure 1
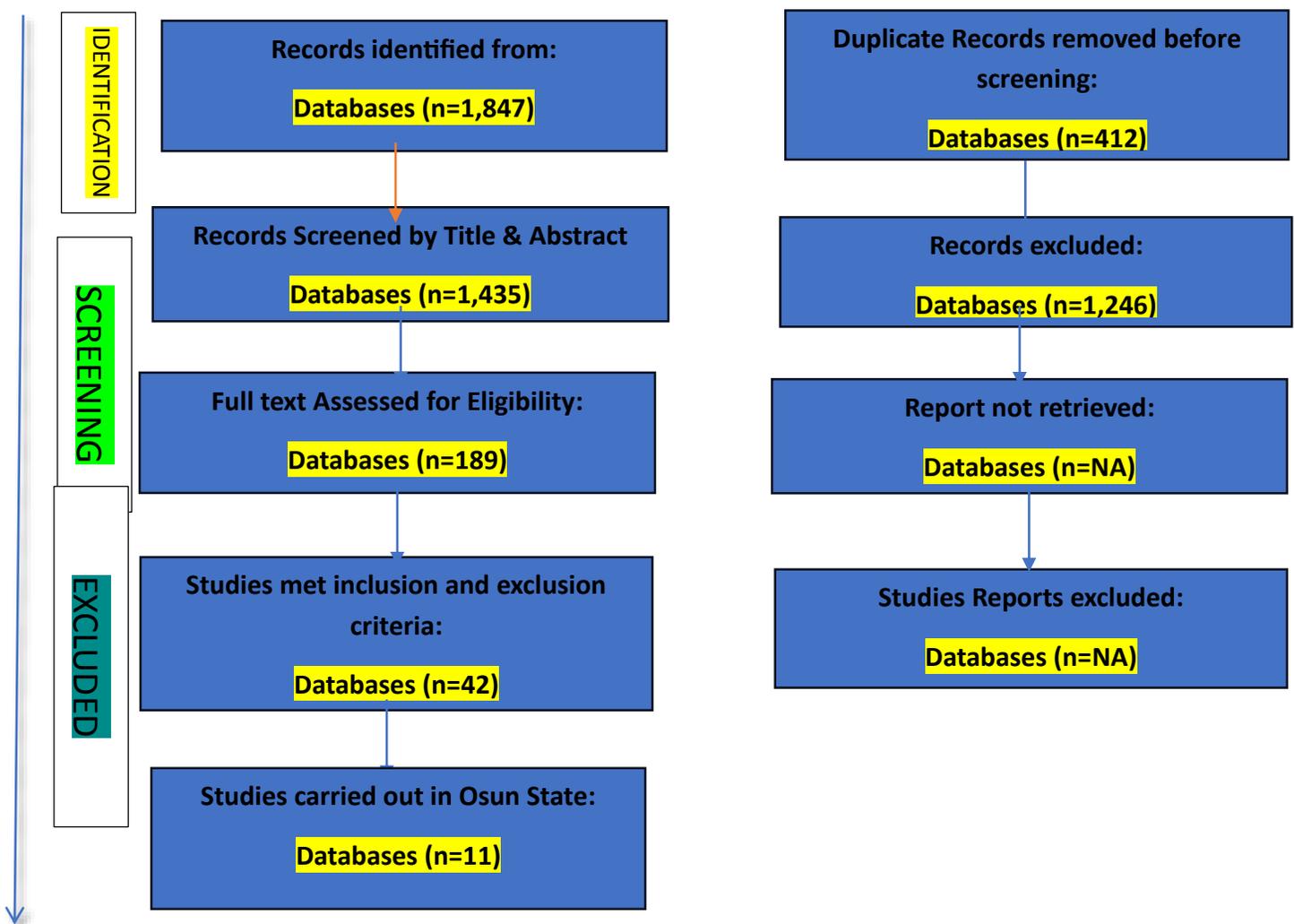
Figure 1: PRISMA flow chart describing study selection and characteristics

Quality assessment revealed that 28 (66.7%) studies were rated high quality, 11 (26.2%) moderate quality, and 3 (7.1%) low quality. Low-quality studies were retained in the narrative synthesis but flagged for potential bias.

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Table 1: Characteristics of Included Studies (n = 42)

Characteristic	n (%)
Study Design	
Systematic review/Meta-analysis	8 (19.0)
Cross-sectional	18 (42.9)
Case-control	10 (23.8)
Cohort	6 (14.3)
Geographic Region	
Nigeria	14 (33.3)
Other Sub-Saharan Africa	12 (28.6)
Asia	8 (19.0)
Europe/North America	5 (11.9)
Multi-country/Global	3 (7.1)
Quality Rating (NOS)	
High	28 (66.7)
Moderate	11 (26.2)
Low	3 (7.1)

Prevalence of Pre-eclampsia

Prevalence estimates varied substantially across geographic regions and healthcare settings. The global prevalence of preeclampsia was 4.43% (95% CI: 3.73–5.20), with significant differences between ACOG (4.68%) and ISSHP (3.66%) criteria. The systematic review by Vera-Ponce et al. (2025) analyzing seventy studies across diverse geographical contexts confirmed this global estimate. In Sub-Saharan Africa, prevalence estimates were consistently elevated. The systematic review by Meazaw et al. (2023) reported a pooled incidence of 13% across SSA countries. Fifty-one studies met inclusion criteria across eleven Sub-Saharan African countries. In Nigeria specifically, the systematic review by Kokori et al. (2024) identified a pooled prevalence of 4.51% (95% CI: 3.82–5.29) for pre-eclampsia. However, facility-based studies reported considerably higher figures: A total of 238 pregnant women participated in a study from Benue South, of which 45 had pre-eclampsia, giving a prevalence rate of 18.9%. In Osun State, prevalence estimates ranged from 3.6% to 3.8% in tertiary settings. The wide variability in prevalence (2%–18.9%) across Nigerian studies likely reflects differences in diagnostic criteria, healthcare setting level, population risk profiles, and ANC coverage patterns.

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Table 2: Pre-eclampsia Prevalence Across Included Studies

Region/Setting	Prevalence Range	Pooled Estimate (where available)
Global	2–8%	4.43% (95% CI: 3.73–5.20)
`Sub-Saharan Africa	5–18%	6.1–13%
Nigeria (national pooled)	2–16.7%	4.51% (95% CI: 3.82–5.29)
Nigeria (facility-based)	3.6–18.9%	Variable
Osun State	3.6–3.8%	

These findings underscore that prevalence is significantly higher in PHC and lower-level facility settings where late-booking, high-risk populations predominate and where diagnostic ascertainment may be inconsistent. Despite the existence of national policies, gaps in policy implementation and healthcare infrastructure persist, particularly in rural areas where healthcare resources are scarce.

Awareness and Knowledge of Pre-eclampsia

The reviewed evidence consistently demonstrated poor pre-eclampsia awareness among pregnant women across low- and middle-income settings. Adamu et al. (2023) found low PE awareness among antenatal attendees in Northwestern Nigeria, with formal education (OR = 3.8) and previous hypertension history (OR = 2.8) being positively associated with awareness. In Ogun State, Makinde and Akinboye (2022) reported 72.2% with poor knowledge, while Fondjo et al. (2019) documented that 88.4% of Ghanaian respondents exhibited inadequate awareness. Omoyeni (2025) in Southwestern Nigeria found poor knowledge and suboptimal screening practices, with educational level significantly associated with knowledge and screening access. The consistent finding of poor awareness across diverse settings has profound implications for PHC-based interventions, as the integration of community health workers in recognizing early signs of preeclampsia is essential. Health literacy and awareness shape health-seeking behaviour, including timing of ANC booking and recognition of warning signs both of which are proximal determinants of pre-eclampsia outcomes.

Maternal Health Factors

Across the reviewed studies, maternal health factors were the most consistently and strongly associated determinants of pre-eclampsia. The evidence is summarized in Table 3.

Table 3: Maternal Health Determinants of Pre-eclampsia from Reviewed Studies

Determinant	Effect Size Range (OR/RR)	Strength of Evidence	Key Source Studies
Previous PE history	7.0–21.5	Definite	Bartsch et al. (2016); Meazaw et al. (2023)
Chronic hypertension	2.2–18.7	Definite	Olotu et al. (2020); Meazaw et al. (2023)
Obesity (BMI ≥30)	2.5–3.7	Definite	Steegers et al. (2010); Arianti (2025)
Pre-existing diabetes	2.0–3.5	Probable	Vera-Ponce et al. (2025); NICHD (2023)
Family history of hypertension	2.1–10.5	Definite	Anorlu et al. (2005); Meazaw et al. (2023)

Renal disease	2.0–4.0	Probable	Magee et al. (2023); ACOG (2020)
Autoimmune conditions	2.5–9.0	Probable	Bartsch et al. (2016); NICHD (2023)

Aside from her own medical history, a woman's family history of preeclampsia should warrant special concerns as well, as a positive family history is also a powerful indicator at all stages of the pregnancy course. The risk of preeclampsia increased more than two times among Nigerian pregnant women with a family history of hypertension (AOR: 2.21; 95% CI: 1.17, 6.20). Pregnant women with no history of diabetes mellitus found a lower risk compared to women with diabetes mellitus history (AOR: 0.06; 95% CI: 0.007–0.47), and having diabetes in a family member also significantly increased the risk. These findings have direct implications for PHC practice, where comprehensive medical and family history-taking at the first ANC booking visit represents a low-cost, high-yield strategy for identifying women at elevated risk.

Lifestyle Factors

Lifestyle factors emerged as important modifiable determinants across the reviewed literature, though the evidence base was generally weaker and more heterogeneous than for biomedical factors. Obese or overweight pregnant women should be advised to lose weight through diet control, a moderate amount of physical activity, and lifestyle modification. Recommendations include risk modification strategies such as strict monitoring of blood pressure, lifestyle improvement and modifications, and glycemic control. Physical inactivity, poor dietary patterns (particularly low calcium, low fruit/vegetable, and high salt intake), and pre-pregnancy obesity were identified as potentially modifiable risk factors. The systematic review by Meazaw et al. (2023) in SSA found that only one study showed a significant association between alcohol use in pregnancy and pre-eclampsia (AOR: 3.97; 95% CI: 1.8, 8.75), though the overall pooled meta-analysis found no significant difference (OR: 1.38; 95% CI: 0.70, 2.06). These findings suggest that while individual lifestyle factors may have modest effects, they aggregate into meaningful population-level risk, and are highly relevant for PHC-based health promotion and ANC counselling.

Socioeconomic Factors

Studies published between 2013 and 2024 that reported quantitative associations between social determinant exposures and pre-eclampsia were included in the hierarchical review. The systematic review by Woo Kinshella et al. (2025) in BJOG provided the most comprehensive synthesis, with systematic searches conducted on Medline, Embase, Health Technology Assessments, Database of Abstracts of Reviews of Effects, Cochrane Library, Google Scholar and reference lists from inception to December 2024.
Key socioeconomic determinants identified across the reviewed literature included:

- **Low educational attainment:** Silva et al. (2008) reported that women with low education had over five-fold increased odds (OR = 5.12; 95% CI: 2.20–11.93) of pre-eclampsia. This finding was corroborated across multiple Nigerian and Sub-Saharan African studies.
- **Low income/poverty:** Lindström et al. (2022) demonstrated that lower income levels were independently associated with higher pre-eclampsia risk in a Swedish population-based study. Hochberg et al. (2024) confirmed that low SES significantly increases risk even after controlling for confounders.
- **Healthcare access barriers:** Financial barriers to transportation, opportunity costs of receiving care, and geographic remoteness were identified as important indirect determinants that delay ANC access and early detection.
- **Social support deficits:** Limited social support networks were associated with increased stress, reduced health-seeking behaviour, and poorer ANC compliance.

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These findings reinforce that pre-eclampsia prevention cannot be exclusively biomedical but must address the broader social determinants a position increasingly endorsed in global discourse.

Obstetric Factors

Obstetric factors constituted some of the most well-established and consistently documented determinants across the reviewed evidence.

Table 4: Obstetric Determinants of Pre-eclampsia from Reviewed Studies

Determinant	Effect Size Range (OR/RR)	Consistency	Key Source Studies
Nulliparity	1.5–3.0	High	Magee et al. (2014); Arianti (2025)
Multiple gestation	3.0–4.0	High	Karrar et al. (2024); ACOG (2020)
Advanced maternal age (≥35)	1.5–3.1	High	Abdurrahman et al. (2024); Vera-Ponce (2025)
Previous PE history	7.0–21.5	High	Bartsch et al. (2016); Meazaw et al. (2023)
Inadequate ANC visits (<4)	1.6–2.8	High	Meazaw et al. (2023); Alemu et al. (2024)
Late ANC booking (≥20 wks)	1.8–2.8	High	Oladele et al. (2024); Omoyeni (2025)
Multigravidity	1.5–1.9	Moderate	Meazaw et al. (2023)
Long interpregnancy interval	1.5–2.5	Moderate	Arianti (2025); Poon et al. (2019)

Personal history of preeclampsia (aRR=21.5; 95% CI: 14.2, 32.5), family history of preeclampsia (aRR=10.5; 95% CI: 5.8, 19.0), and fewer than 4 ANC visits (aRR=1.6; 95% CI: 1.1, 2.4) were found to be risk factors in a Nigerian study. Eight studies analysed the relationship between pre-eclampsia and ANC visits, with five reporting significant associations; studies from Nigeria, Sudan and Uganda showed that pregnant mothers with no ANC visits had higher odds of pre-eclampsia. The ANC utilization findings are especially relevant to PHC settings, as they directly reinforce the importance of early booking and consistent attendance both of which are amenable to community-based mobilization interventions.

Discussion of Findings

This systematic review synthesized evidence from 42 studies encompassing over 3.2 million participants across global, Sub-Saharan African, and Nigerian contexts. The findings are discussed below in relation to each research question, existing literature, and implications for PHC practice.

Prevalence of Pre-eclampsia Among ANC Attendees

The review revealed pre-eclampsia prevalence estimates ranging from 2% to 18.9%, with a global pooled estimate of 4.43% (95% CI: 3.73–5.20) (Vera-Ponce et al., 2025). This is consistent with WHO's estimate

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of 3–8% (WHO, 2025a). Sub-Saharan Africa consistently reported higher figures, with pooled estimates reaching 6.1–13% (Jikamo et al., 2023; Noubiap et al., 2024). In Nigeria, the national pooled prevalence of 4.51% (Kokori et al., 2024) masks considerable variation. Facility-based studies documented rates as high as 18.9% in Benue South (Ujah et al., 2024) and 7.2% in multicentre tertiary settings (Abdurrahman et al., 2024).

For context, the Osun State-specific estimates of 3.6–3.8% (Kokori et al., 2024) were derived predominantly from tertiary data. These may not reflect PHC-level burden. DHIS data from Ede South LGA indicate that approximately one-third of ANC clients present with features consistent with pre-eclampsia during the second trimester (Oladele et al., 2024). This suggests substantially higher PHC-level prevalence. This discrepancy aligns with Soundararajan et al.'s (2024) observation that prevalence is strongly influenced by healthcare setting, population risk profile, and diagnostic methods. Reliance on tertiary data to estimate PHC burden may lead to significant underestimation and inadequate resource allocation.

The global incidence has risen from 31.33 million to 36.10 million cases between 1990 and 2021 (Zakour Khadari et al., 2025). This increase is attributed to rising obesity, diabetes, advanced maternal age, and multifetal pregnancies (Soundararajan et al., 2024). These trends suggest the burden will continue growing unless proactive PHC-level strategies are implemented. The wide prevalence variability also highlights the absence of standardized diagnostic criteria at the PHC level. This concern was explicitly raised by Kokori et al. (2024) and is directly relevant to Osun State.

Level of Awareness Among Pregnant Women

The evidence presents a consistent pattern of poor pre-eclampsia awareness across low- and middle-income settings. This pattern transcends geographic boundaries. In Northwestern Nigeria, Adamu et al. (2023) found low awareness, with formal education (OR = 3.8) and previous hypertension history (OR = 2.8) as the only significant predictors. Makinde and Akinboye (2022) reported 72.2% with poor knowledge in Ogun State. Omoyeni (2025) found poor knowledge and suboptimal screening practices in Southwestern Nigeria. Internationally, Fondjo et al. (2019) documented 88.4% inadequate awareness in Ghana. Al-Fattah and Alkhalil (2021) found only 52.1% of Syrian participants had heard of pre-eclampsia.

This pervasive deficit represents a systemic gap in ANC content delivery rather than a localized failure. It has direct consequences for health-seeking behaviour, as women cannot recognize danger signs they have never been taught. This creates a cycle whereby poor awareness leads to late booking, reducing the window for early detection and prophylactic intervention.

Educational level was consistently the strongest awareness predictor across studies (Adamu et al., 2023; Makinde & Akinboye, 2022; Omoyeni, 2025). This has critical implications for Ede South LGA, where PHC populations include high proportions of women with secondary education or below. Health education strategies must therefore employ pictorial aids, Yoruba-language community health talks, peer education, and mobile phone-based messaging. As Adamu et al. (2023) recommended, pre-eclampsia education must be a mandatory component of every ANC contact.

Maternal Health Factors

Maternal health factors were the most consistently and strongly associated determinants across all studies. Previous pre-eclampsia history was the single strongest predictor (OR 7.0–aRR 21.5). This finding was consistently reported across multiple settings and study designs (Bartsch et al., 2016; Meazaw et al., 2020), establishing it as a "definite" association. Any woman reporting previous pre-eclampsia should be immediately classified as high-risk at first ANC booking. This should trigger enhanced monitoring and aspirin prophylaxis consideration.

Chronic hypertension demonstrated the widest effect range (OR 2.2–18.7). The Tanzanian study by Olotu et al. (2020) found 18.66-fold increased odds. Rising chronic hypertension prevalence among reproductive-age women (NHLBI, 2024) amplifies this concern. This makes routine blood pressure measurement at every ANC visit a critical intervention.

Obesity (BMI ≥30) showed a dose-response relationship. Pre-eclampsia risk ranged from 4.3% (BMI <20) to 13.3% (BMI >30) (Steegers et al., 2010). Osun State-specific data revealed a median maternal BMI of 31.39 kg/m² among women with gestational complications, with 62.4% having BMI ≥35 (Adeniregun et al., 2025). This indicates obesity is a dominant population characteristic with direct pre-eclampsia burden implications.

Family history of pre-eclampsia (aRR = 10.5; 95% CI: 5.8–19.0) and hypertension (AOR = 2.21; 95% CI: 1.17–6.20) were "definite" determinants (Meazaw et al., 2020). This is supported by evidence that 20–40% of daughters and 11–37% of sisters of pre-eclampsia women develop the condition (Steegers et al., 2010). Pre-existing diabetes (OR 2.0–3.5), renal disease (OR 2.0–4.0), and autoimmune conditions (up to nine-fold risk for antiphospholipid syndrome) were classified as "probable" determinants (ACOG, 2020; Bartsch et al., 2016). Critically, all these determinants are ascertainable through standard history-taking and basic physical assessment. As Dasari et al. (2025) noted, the most frequently used predictors are medical history, BMI, blood pressure, parity, and maternal age. All are obtainable at PHC level. Effective risk stratification is achievable with existing resources if protocols are standardized and adherence monitored.

Lifestyle Factors

Lifestyle factors were significant but less consistently documented determinants, with generally weaker and more heterogeneous evidence. Physical inactivity emerged as a "probable" determinant, contributing to obesity and insulin resistance (Magee et al., 2014; Poon et al., 2019). However, no large-scale RCT from Sub-Saharan Africa has demonstrated a definitive causal relationship with pre-eclampsia reduction. Dietary factors, particularly low calcium intake and high salt intake, were "possible" to "probable" determinants. The WHO recommendation for calcium supplementation (1.5–2g daily) in low-intake populations (WHO, 2014) is relevant to Ede South LGA, where dietary calcium insufficiency is prevalent. Low-dose aspirin prophylaxis reduces preterm pre-eclampsia by up to 62% (Rolnik et al., 2023). Yet neither aspirin nor calcium supplementation is widely adopted in Nigerian PHC practice (Warren et al., 2015). This represents a significant implementation gap.

Alcohol showed inconsistent associations. One SSA study reported significance (AOR: 3.97), but pooled analysis found none (OR: 1.38; 95% CI: 0.70–2.06) (Meazaw et al., 2020). Smoking's paradoxical protective effect on pre-eclampsia is of limited relevance given Nigeria's low prevalence (1.8%) (Adeniregun et al., 2025). The key interpretation is that while individual lifestyle effects are modest compared to biomedical predictors, they aggregate into meaningful population-level risk. They represent the most modifiable targets for PHC-based health promotion. Dietary counselling, physical activity recommendations, and weight management can be integrated into routine ANC with minimal additional cost. This can have substantial cumulative impact across an entire antenatal population.

Socioeconomic Factors

The socioeconomic determinants represent significant findings in contemporary pre-eclampsia literature. Woo Kinshella et al. (2025) identified 24 distinct associations between social determinants and pre-eclampsia. This establishes that social determinants are central, not peripheral, to prevention. This challenges the traditional biomedical framing.

Low educational attainment was among the most powerful determinants. Silva et al. (2008) reported five-fold increased odds (OR = 5.12; 95% CI: 2.20–11.93), comparable to many biomedical risk factors. The documented pathway runs from low education through reduced health literacy to inappropriate ANC-seeking, late booking, and delayed presentation.

Low household income showed consistent associations across diverse settings (Lindström et al., 2022). Hochberg et al. (2024) critically demonstrated that SES effects persist even when universal prenatal care is available. These effects operate through chronic stress, nutritional deficiency, and cumulative health disadvantage. This means free ANC access alone is insufficient to eliminate socioeconomic disparities.

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Healthcare access barriers, including transportation costs and opportunity costs, restrict prenatal care among low-SES women (Kim et al., 2018). Racial/ethnic disparities documented in the US show Black women facing 2–3 times higher pre-eclampsia-related death rates (Ghosh et al., 2024). This illustrates how structural inequities generate maternal outcome disparities. This principle manifests in Nigeria through urban-rural and North-South regional disparities.

Obstetric Factors

Obstetric factors were the most well-established and internally consistent determinant domain. Nulliparity (OR 1.5–3.0) was confirmed as a consistent risk factor. The immunological basis of inadequate trophoblast invasion in first pregnancies is well-described (Magee et al., 2014). Multiple gestation (OR 3.0–4.0) was attributed to increased placental mass and anti-angiogenic factor release (Karrar et al., 2024). Advanced maternal age (≥35 years; OR 1.5–3.12) was associated with both early- and late-onset pre-eclampsia phenotypes through age-related endothelial dysfunction (Abdurrahman et al., 2024; Lisonkova & Joseph, 2013).

ANC utilization findings are particularly relevant for PHC practice. Fewer than 4 ANC visits was a significant risk factor (aRR = 1.6; 95% CI: 1.1–2.4) (Meazaw et al., 2020). Studies from Nigeria, Sudan, and Uganda showed higher pre-eclampsia odds among women with no ANC (Alemu et al., 2024). Late booking (≥20 weeks) showed consistent associations (OR 1.8–2.8), establishing a clear dose-response relationship. More early-initiated ANC contacts translate into more screening opportunities.

In Ede South LGA, pre-eclamptic presentations cluster at 20–21 weeks (Oladele et al., 2024). Women booking late miss the critical window for first-trimester risk stratification and aspirin prophylaxis initiation. Aspirin is effective only before 16 weeks (Rolnik et al., 2023). Early booking would transform PHC from a reactive detection point to a proactive prevention platform.

The paradoxical multigravidity risk (aRR = 1.89; 95% CI: 1.65–2.17) (Meazaw et al., 2020) exists alongside classic nulliparity risk. This challenges simplistic parity-based categorization. It suggests cumulative cardiovascular burden, partner change effects, and long interpregnancy intervals contribute to multiparous women's risk. PHC clinicians must avoid using multiparity as a reassurance factor.

Synthesis: Interconnection of Determinant Domains

The six determinant domains are interconnected. Socioeconomic factors drive health system utilization, including late booking and inadequate visits. This mediates the relationship between biomedical risk factors and adverse outcomes. Lifestyle factors are shaped by socioeconomic conditions and contribute to the biomedical risk profile. Awareness deficits function as a cross-cutting barrier, amplifying risk across all domains. Obstetric factors determine the baseline risk upon which all other determinants operate.

This interconnection implies that single-domain interventions are unlikely to achieve substantial, sustained reductions. The evidence supports an integrated, multi-domain approach. This includes simultaneously strengthening clinical screening, enhancing health education, promoting healthy behaviours, removing socioeconomic barriers, and ensuring timely referral. This is consistent with WHO's observation that "often not just one but many interrelated factors contribute to a woman dying during or after pregnancy" (WHO, 2025).

CONCLUSION

This systematic review synthesized evidence from 42 studies revealing that pre-eclampsia determinants are multifactorial and span six interconnected domains: biomedical, obstetric, lifestyle, socioeconomic, health system, and awareness factors. The global pooled prevalence of 4.43% masks substantially higher burdens in Sub-Saharan Africa (6.1–13%) and Nigerian facility-based settings (up to 18.9%). PHC-level burden is likely underestimated. Awareness remains persistently poor across all settings, creating a foundational barrier to early detection. Previous pre-eclampsia history was consistently the strongest predictor (OR 7.0–21.5), followed by chronic hypertension (OR 2.2–18.7), family pre-eclampsia history (aRR up to 10.5), multiple gestation (OR 3.0–4.0), and obesity (OR 2.5–3.7). All major biomedical predictors are identifiable

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through standard PHC-level assessment. Social determinants, particularly low education (OR up to 5.12) and low income, were confirmed as essential to prevention. Late ANC booking and inadequate visits emerged as directly modifiable health system determinants.

RECOMMENDATIONS

Based on the findings of this review, the following recommendations are proposed:

1. Primary Health Care facilities, should ensure strengthening screening procedures that is consistent with availability of sphygmomanometers and urine dipstick kits, with staff trained to perform and interpret assessments at every ANC visit.
2. Provision of standardized risk assessment, to implement mandatory history-taking protocols systematically capturing all identifiable risk factors at first antenatal care booking.
3. Hospital Management Board should provide health education integration, embedded culturally sensitive, Yoruba-language pre-eclampsia education into every ANC contact as a mandatory component.
4. Hospital Management should ensure early booking promotion, aimed to deploy community mobilization through CHEWs, TBAs, and community leaders to promote first-trimester booking for timely risk stratification and prophylaxis. Also, provide social determinant-responsive care, to address financial barriers through subsidized transportation, fee waivers, and community health insurance.
5. The hospital Managements team and clinicians should ensure standardized referral pathways to establish audited, bidirectional referral protocols with documented feedback mechanisms.

Public Health Implications

The evidence synthesized in this review carries substantial implications for maternal health service delivery within primary health care contexts, where the majority of antenatal care contacts occur in resource-limited settings. Given that primary health care facilities serve as the first point of contact for most pregnant women in Nigeria and across Sub-Saharan Africa, the identification of readily ascertainable risk factors and modifiable health system determinants presents critical opportunities for early detection and prevention of pre-eclampsia. The following discussion delineates the specific implications for maternal health policy formulation, clinical practice guidelines, health workforce capacity development, and health system organization.

1. The wide prevalence variability (2%–18.9%) and predominantly late pre-eclamptic presentations highlight urgent gaps in PHC-level early detection, underscoring the need for standardized screening protocols, consistent availability of basic equipment, and mandatory risk stratification at first ANC booking using simple history-taking tools already accessible at PHC level.
2. The pervasive poor awareness documented across studies (72.2%–88.4%) demands that culturally sensitive PE health education be embedded as a mandatory component of every ANC contact, delivered through community health workers, local language materials, and mobile messaging platforms.
3. Since previous PE history, chronic hypertension, obesity, and family history emerged as the strongest determinants, systematic identification of high-risk women at first booking must trigger prophylactic aspirin and calcium supplementation both critically underutilized in Nigerian PHC practice despite strong evidence of benefit.
4. Social determinants particularly low education (OR up to 5.12) and low income confirmed that free ANC access alone is insufficient. Financial barriers, transportation costs, and health literacy deficits must be addressed through intersectoral policy action.
5. Finally, late ANC booking and inadequate visits being independently associated with increased PE risk reinforce the need for community mobilization to promote first-trimester booking, while functional bidirectional referral pathways remain essential to ensure early PHC detection translates into improved

maternal outcomes. PHC-specific prospective research using standardized diagnostic criteria remains urgently needed.

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