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Systematic Literature Review of Preeclampsia Prevention Models: Implications for Developing an Integrated Model in Indonesia

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Abstract. Preeclampsia is a leading cause of maternal morbidity and mortality worldwide, including in Indonesia. Preventive strategies such as calcium supplementation, community-based interventions, and self-monitoring of blood pressure have been widely studied. However, these approaches remain fragmented and lack integration into a comprehensive management model. This study aimed to analyze existing preeclampsia prevention management models reported in international guidelines and trials and to synthesize the evidence as a basis for developing an integrated prevention model for Indonesia. A *Systematic Literature Review* was conducted following PRISMA guidelines. Searches in PubMed, Scopus, ScienceDirect, and Google Scholar identified 1,236 records. After screening, 12 studies were included, comprising international guidelines, Cochrane reviews on calcium. The review identified three major categories of prevention models: (1) risk screening and prediction with biomarkers; (2) education and empowerment, including self-monitoring; and (3) integrated guideline-based care emphasizing high-quality antenatal services and preventive supplementation. Evidence indicates greater effectiveness when these strategies are applied holistically. Current preeclampsia prevention models show effectiveness when integrated into a holistic management framework that combines risk screening, maternal and family education, and primary health services aligned with international guidelines. This systematic review provides an evidence-based foundation for developing an integrated preeclampsia prevention management model.
Keywords: preeclampsia, prevention, management model, systematic literature review, Indonesia

1 Introduction

Preeclampsia remains a leading cause of maternal morbidity and mortality worldwide and continues to burden health systems in low- and middle-income countries, including Indonesia [1]. International guidance emphasizes early risk stratification and standardized pathways of antenatal care to mitigate adverse outcomes, yet implementation and coverage vary widely across settings [2]. Foundational recommendations from the WHO and updated national guidelines (e.g., NICE) highlight diagnosis, prevention, and service organization as core levers to reduce risk [2].

Evidence for specific preventive components has strengthened over the past decade [3]. High-dose calcium supplementation (≥1 g/day) lowers the risk of preeclampsia—particularly where dietary calcium intake is low—while low-dose aspirin after 12 weeks' gestation is recommended for women at elevated risk [3]. These measures are consistently reflected in systematic reviews and preventive-service recommendations [4].

Alongside pharmacologic prevention, models that enhance women's participation in care—such as blood pressure self-monitoring and digitally enabled follow-up—have been tested in randomized trials [5]. The BUMP program evaluated self-monitoring (with and without telemonitoring) against usual care to understand effects on hypertension detection and control in higher-risk pregnancies, informing how self-care can be incorporated into routine pathways even when headline outcomes are neutral [6].

At the community and primary-care interface, the CLIP program developed and tested packages addressing triage, initial treatment, and transport for women with hypertensive disorders of pregnancy in resource-constrained settings. Although overall reductions in composite adverse outcomes were challenging to demonstrate, CLIP clarified operational components for community-level management and referral systems that can be adapted locally [7].

Risk-screening models increasingly incorporate angiogenic biomarkers (e.g., PlGF and the sFlt-1/PlGF ratio) to refine diagnosis and short-term risk prediction in suspected preeclampsia. Health-technology assessments and operational guidance (e.g., NHS Scotland) describe how these tests can complement clinical assessment and help target surveillance and referral, while professional society consensus (ISSHP) standardizes classification and management [8].

Taken together, the literature shows that prevention efforts have often been implemented as discrete components—supplementation, aspirin, self-monitoring, community packages, or biomarker-guided triage—rather than as a coordinated continuum of care. Synthesizing these strands under an integrated model anchored in international guidance and adapted to local resources and sociocultural context is therefore a logical next step for Indonesia [9].

2 Methods

We conducted a Systematic Literature Review guided by PRISMA 2020. Searches were performed in PubMed/MEDLINE, Scopus, ScienceDirect, and Google Scholar for records published January 2011–August 2025 in English or Indonesian. Search terms combined concepts for preeclampsia and prevention/management models (e.g., aspirin, calcium, self-monitoring, community-based interventions, PlGF, sFlt-1/PlGF, integrated care, guidelines) using Boolean operators. We supplemented database searches with screening of guideline portals (WHO, NICE, professional societies) and backward/forward citation tracking.

Eligibility covered studies on pregnant populations that evaluated preeclampsia prevention models/strategies: (1) risk screening/prediction (clinical algorithms, biomarkers), (2) education & empowerment (e.g., blood-pressure self-monitoring, community health worker programs), and (3) integrated, guideline-based care and preventive supplementation (calcium, low-dose aspirin). Two reviewers independently screened titles/abstracts and full texts, recorded PRISMA counts, and extracted data on setting/design, population, intervention components, comparators, outcomes, and implementation features. Risk of bias was appraised with ROB-2 (randomized/cluster trials), ROBINS-I (non-randomized), JBI/CASP (observational/qualitative), AMSTAR-2 (systematic reviews), and selected AGREE II items (guidelines). Owing to heterogeneity, findings were synthesized narratively and organized a priori into the three model categories above, with attention to effect direction, consistency, and transferability to Indonesian primary care.

Records identified through database searching (n=1,236), Records after duplicates removed (n=980), Records screened (title & abstract) (n=980), Full-text articles assessed for eligibility (n=74) Studies included in qualitative synthesis (n=12)

3 Results And Discussion

3.1 Results

3.1.1 Corpus composition and model taxonomy

From 1,236 records, 12 sources met eligibility: four international guidelines/consensus (WHO 2012, WHO 2018–calcium, NICE NG133, ISSHP 2022), one preventive-service recommendation (USPSTF 2021—aspirin), two randomized trials of blood-pressure self-monitoring (BUMP 1/2), one community package trial (CLIP), one Cochrane review on calcium, and two biomarker-focused sources (narrative review; operational guidance). Findings clustered into three model categories: (a)

risk screening/prediction**,** (b) education & empowerment (self-monitoring/education), and (c) integrated guideline-based care with preventive supplementation and tiered referral [10-13]

3.1.2 Risk screening/prediction (clinical algorithms and biomarkers)

ISSHP provides a standardized classification for hypertensive disorders of pregnancy and management pathways that support consistent risk assessment across levels of care. Biomarker evidence indicates that placental growth factor (PlGF) and the sFlt-1/PlGF ratio enhance short-term risk prediction among women with suspected preeclampsia beyond clinical assessment alone. Operational guidance (NHS Scotland) details test indications, reporting, and common thresholds (e.g., ratio 38) to inform triage and referral decisions in secondary care. While clinical utility is clear where laboratory capacity exists, adoption at primary level may be constrained by infrastructure and cost [12,19-21].

3.1.3 Education & empowerment (self-monitoring of blood pressure and education)

The BUMP trials tested home blood-pressure self-monitoring in higher-risk pregnancy (BUMP 1) and in women with hypertensive disorders (BUMP 2) [15]. Across the two RCTs, self-monitoring improved detection processes and informed management, though effects on primary clinical endpoints were mixed; nevertheless, the trials clarified how patient-generated data and escalation protocols can be embedded safely and acceptably into routine antenatal care[5]. Observational and process findings support combining self-monitoring with targeted education to strengthen adherence and timely care-seeking [15].

3.1.4 Integrated guideline-based care and preventive supplementation (aspirin, calcium)

WHO and NICE converge on structured antenatal pathways with risk assessment, prevention, and clear referral steps; USPSTF recommends low-dose aspirin from 12 weeks' gestation for women at increased risk to reduce preterm preeclampsia and related morbidity [10]. The Cochrane review shows calcium supplementation lowers hypertensive disorders, particularly where dietary intake is low, which underpins WHO's 2018 programmatic guidance [11]. At community level, CLIP operationalized triage, first-line actions, and referral strengthening; although composite outcome reductions were inconsistent, implementation lessons on workflows and community-facility linkages are highly informative for resource-constrained settings [13].

3.2 Discussion

No single intervention suffices to prevent preeclampsia [11]. Biomarker-guided pathways refine short-term risk where available; self-monitoring and education enhance engagement and earlier clinical response; and aspirin (for high-risk women) plus calcium (in low-intake populations) provide high-certainty, scalable pharmacoprophylaxis [13]. When these elements are combined into a coordinated, guideline-anchored continuum—screening → education/self-care → targeted prophylaxis → timely referral—programs are more likely to achieve consistent and equitable prevention at scale [20,21].

A pragmatic integrated model should prioritize: (i) universal clinical risk stratification in primary care using ISSHP/NICE algorithms, adding PlGF/sFlt-1 where laboratory support exists to clarify ambiguous cases; (ii) routine low-dose aspirin for eligible high-risk women and calcium in low-intake populations, embedded in antenatal care workflows; (iii) structured self-monitoring of blood pressure with clear escalation thresholds and targeted education; and (iv) strengthened tiered referral and readiness aligned with WHO/NICE. Barriers—validated devices, workforce training (midwives/CHWs), laboratory capacity, and data systems—can be addressed via phased roll-out, standardized training, and monitoring dashboards for coverage, fidelity, and timeliness of referral [14,15].

Priority gaps include: cost-effectiveness and long-term impact of bundled strategies in diverse primary-care settings; local adaptation of community packages (e.g., CLIP) integrated with digital/self-monitoring components; and pragmatic effectiveness-implementation studies measuring clinical endpoints (preeclampsia incidence, preterm birth) alongside process indicators (timely detection, adherence, referral timeliness) and acceptability [14]. Hybrid designs can accelerate learning cycles and support sustained integration across community and facility levels [16].

Strengths include cross-guideline convergence (WHO, NICE, ISSHP, USPSTF) and high-quality synthesis for calcium (Cochrane). Limitations stem from heterogeneity in populations, contexts, and intervention bundles, and from restricted biomarker access in primary care, which justified a narrative synthesis rather than meta-analysis. Transferability considerations are central when adapting models to Indonesia's tiered health system [17,18].

4 Conclusion

This review shows that no single intervention prevents preeclampsia in isolation; the most promising approach is an integrated model that combines (i) systematic risk stratification using standardized clinical algorithms and, where feasible, angiogenic biomarkers, (ii) education and empowerment through blood-pressure self-monitoring with clear escalation rules, and (iii) targeted prophylaxis (low-dose aspirin for high-risk women and calcium where dietary intake is low) embedded within high-quality antenatal care and tiered referral systems. Synthesizing these components into a coordinated continuum of care offers a practical pathway to improve early detection, streamline referral, and reduce the burden of hypertensive disorders in pregnancy.

For Indonesia, implementation should proceed phased and pragmatic: start with universally applicable, low-cost measures (clinical risk algorithms, aspirin for eligible women, calcium in low-intake populations, standardized education and self-monitoring), while progressively adding biomarker-guided pathways in facilities with laboratory capacity. Success will depend on workforce training (midwives/CHWs), availability of validated home BP devices, reliable supply chains, and routine monitoring of coverage, fidelity, timeliness of referral, and equity. Future research should prioritize pragmatic effectiveness-implementation studies in primary care to evaluate combined packages on clinical and process outcomes, alongside cost-effectiveness and acceptability, to support sustained scale-up and policy integration.

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