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REVIEW ARTICLE

Malaria in Pregnancy: Systematic Review of Maternal and Fetal Outcomes and Effectiveness of Preventive Strategies

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Abstract

This literature review aims to systematically assess the maternal and fetal health risks associated with malaria infection during pregnancy and evaluate the effectiveness of current prevention and management strategies. A narrative synthesis approach was employed, screening articles published from January 2014 to March 2025 in PubMed, ScienceDirect, and SpringerLink. Of 68 initially identified articles, 20 met the inclusion criteria, focusing on clinical outcomes such as anemia, preeclampsia, low birth weight, and neonatal mortality in malaria-endemic settings. The review demonstrates that malaria during pregnancy significantly increases the risk of maternal anemia (OR 2.40), placental malaria (up to 65.9% in primigravidas), preterm birth (OR 1.65), and neonatal death (OR 1.40), with highest burdens in sub-Saharan Africa and vulnerable groups. Key interventions–intermittent preventive treatment in pregnancy (IPTp) and long-lasting insecticidal nets (LLINs)–consistently reduce these risks, but face implementation barriers such as drug resistance and limited healthcare access. This review highlights the urgent need for further research on malaria vaccination in pregnancy and innovative diagnostic technologies, as well as cross-sectoral efforts to address socioeconomic barriers and strengthen surveillance, policy, and health system capacity.

Keywords: Malaria in Pregnancy, Maternal Health Risks, Fetal Outcomes, Placental Malaria, Intermittent Preventive Treatment (IPTp)

Abstrak: Literature review ini bertujuan untuk menilai secara sistematis risiko kesehatan maternal dan fetal yang terkait dengan infeksi malaria selama kehamilan serta mengevaluasi efektivitas strategi pencegahan dan penatalaksanaan terkini. Pendekatan sintesis naratif digunakan dengan menelaah artikel yang dipublikasikan antara Januari 2014 hingga Maret 2025 di PubMed, ScienceDirect, dan SpringerLink. Dari 68 artikel yang diidentifikasi, 20 memenuhi kriteria inklusi dengan fokus pada luaran klinis seperti anemia, preeklamsia, berat badan lahir rendah, dan kematian neonatal pada wilayah endemis malaria. Hasil tinjauan menunjukkan bahwa malaria selama kehamilan secara signifikan meningkatkan risiko anemia maternal (OR 2,40), malaria plasenta (hingga 65,9% pada primigravida), kelahiran prematur (OR 1,65), dan kematian neonatal (OR 1,40), dengan beban tertinggi di Afrika Sub-Sahara dan kelompok rentan. Intervensi utama–intermittent preventive treatment in pregnancy (IPTp) dan penggunaan kelambu berinsektisida jangka panjang (LLINs)–secara konsisten menurunkan risiko ini, namun masih menghadapi hambatan implementasi seperti resistensi obat dan keterbatasan akses layanan kesehatan. Tinjauan ini menyoroti kebutuhan mendesak akan penelitian lebih lanjut terkait vaksinasi malaria pada kehamilan dan inovasi teknologi diagnostik, serta upaya lintas sektor untuk mengatasi hambatan sosial ekonomi dan memperkuat sistem surveilans, kebijakan, serta kapasitas sistem kesehatan.

Kata kunci: Malaria pada Kehamilan, Risiko Kesehatan Maternal, Luaran Fetal, Malaria Plasenta, Intermittent Preventive Treatment (IPTp)

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INTRODUCTION

Malaria remains a persistent global health threat, especially in tropical and subtropical regions. The World Health Organization (WHO) reported an estimated 249 million malaria cases and 608,000 deaths worldwide in 2022, with sub-Saharan Africa accounting for 95% of malaria cases and deaths (WHO, 2023). Pregnant women represent one of the most vulnerable populations due to physiological and immunological changes that impair the maternal immune response, increase susceptibility to infection, and allow for parasite sequestration in the placenta (Kamanzi, 2024; Rulisa, 2014; Berhe et al., 2023). Recent epidemiological data indicate that each year, approximately 30 million pregnancies in sub-Saharan Africa are at risk of malaria exposure, with Indonesia remaining the country with the second-highest malaria burden in Asia after India (Ministry of Health, Republic of Indonesia, 2023; Uwimana, 2024). In 2022, Indonesia reported 443,530 malaria cases, of which 89% originated from Papua and its surrounding provinces, with a modest decrease to 418,546 cases in 2023. These figures underscore the ongoing public health challenge in both global and national contexts.

The pathogenesis of malaria in pregnancy involves complex physiological interactions between the Plasmodium parasite and the maternal-fetal interface. Elevated levels of progesterone and the development of the placenta modulate the maternal immune system, resulting in increased vulnerability to infection, particularly by Plasmodium falciparum and Plasmodium vivax (Berhe et al., 2023; Kamanzi, 2024). The parasite's ability to sequester in the placenta disrupts nutrient and oxygen transfer to the fetus, leading to a spectrum of adverse maternal and fetal outcomes. Key risk factors for malaria in pregnancy include maternal age (especially younger women ≤23 years), low parity (primigravida or secundigravida), HIV infection, lack of antenatal care, and poor socioeconomic status (Akinnawo et al., 2022; Omer et al., 2017; Kamanzi, 2024). The spread of efficient malaria vectors such as Anopheles stephensi into new regions and increasing resistance to insecticides further exacerbate the transmission risk and challenge existing control strategies (Hamlet et al., 2022; Koffi et al., 2023).

The adverse impacts of malaria during pregnancy are well documented in the literature. For mothers, malaria increases the risk of anemia (adjusted odds ratio [AOR] 1.72), severe complications such as acute respiratory distress syndrome and preeclampsia, and in some cases, can be fatal (Nuzula et al., 2020; Palem & Pal, 2019; Das et al., 2024). Meta-analyses reveal that maternal malaria infection is associated with a significantly higher risk of anemia (OR 2.40), preterm birth (OR 1.65), and spontaneous miscarriage, particularly in the first trimester (Das et al., 2024; Gaoussou et al., 2022). For the fetus, placental malaria is linked to intrauterine growth restriction (IUGR), low birth weight (OR 1.99), preterm delivery, and stillbirth (Chua et al., 2021; Berhe et al., 2023; Das et al., 2024). These complications contribute substantially to maternal and infant morbidity and mortality in endemic settings.

Despite advances in malaria control, substantial research and policy gaps persist, particularly in high-burden countries such as Indonesia and across Southeast Asia. Evidence-based policy advocacy is urgently needed to enhance the implementation of proven interventions, such as intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine and the consistent use of insecticide-treated nets (ITNs), which have demonstrated effectiveness in reducing malaria-related morbidity and mortality among pregnant women (Gill & Anvikar, 2024; Uwimana, 2024). Nevertheless, significant real-world challenges remain. These include the emergence of drug-resistant parasite strains, logistical constraints in distributing preventive interventions, limited healthcare infrastructure, and persistent socioeconomic and cultural barriers to uptake (Koffi et al., 2023; Yulizawati et al., 2023; Loyce, 2024). Addressing these barriers requires multisectoral strategies, community engagement, and sustained investment in health systems.

The unique contribution of this review lies in synthesizing recent literature to clarify the multifaceted risks malaria poses to both maternal and fetal health, examining the pathophysiological mechanisms, and highlighting the critical need for integrated prevention and management strategies. This review also identifies key research gaps and advocates for stronger policy responses and innovative solutions tailored to the specific challenges faced by high-burden regions. By illuminating both the scientific and practical dimensions of malaria in pregnancy, this review aims to inform the development of more effective and contextually appropriate interventions and policies.

METHODS

This literature review employed a descriptive qualitative approach, specifically utilizing narrative synthesis, to integrate findings from diverse studies on malaria infection during pregnancy and its impact on maternal and fetal health. Narrative synthesis was chosen to accommodate the heterogeneity of study designs, research populations, and outcomes present in the literature. This approach enables thematic grouping and in-depth interpretation of results, making it particularly relevant for complex public health topics such as malaria in pregnancy where quantitative meta-analysis may not be appropriate due to methodological variations (Gill & Anvikar, 2024; Das et al., 2024).

A systematic search was conducted in April 2025 using three major scientific databases: PubMed, ScienceDirect, and SpringerLink. The search was limited to articles published between January 2014 and March 2025, to ensure that the synthesis reflects the most recent evidence. The following keyword combinations were used with Boolean operators (AND, OR): "malaria in pregnancy," "Plasmodium infection," "maternal health," "fetal outcomes," and "pregnancy complications due to malaria."

The inclusion criteria for this review encompassed original research articles, systematic reviews, or clinical guidelines that specifically focused on malaria infection during pregnancy. Studies were eligible if they reported clinical outcomes for either the mother–such as anemia, preeclampsia, or mortality–or for the fetus, including low birth weight, preterm birth, or neonatal death. Only articles published in English or Indonesian were considered, and studies needed to be conducted in malaria-endemic settings or provide relevant global or regional context. Conversely, exclusion criteria comprised opinion or editorial articles, studies not addressing malaria in pregnancy, research with unclear methodology or missing essential data, and duplicate publications.

The article selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and

Meta-Analyses) guidelines, consisting of four sequential stages: identification, screening, eligibility assessment, and inclusion. Initially, 68 articles were identified (PubMed 42, ScienceDirect 18, SpringerLink 8), plus 3 additional articles from other sources. After removal of 11 duplicates, titles and abstracts of 60 articles were screened. Of these, 27 were excluded for not meeting inclusion criteria, and 33 underwent full-text assessment. Finally, 20 articles that fully met the criteria were included in the review. The PRISMA flowchart and a table summarizing the characteristics of included studies are provided to ensure process transparency and facilitate reproducibility (see Figure 1 and Table 2 in appendix).

Quality assessment of each included article was performed using a combination of the PRISMA checklist and key components of the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) framework. The assessment considered study design, risk of bias, methodological transparency, sample size, and consistency of findings. Only studies rated as moderate to high quality were included in the synthesis, with disagreements between reviewers resolved by consensus. Two independent reviewers conducted the selection and appraisal process to enhance objectivity and minimize bias. The use of reference management software (Mendeley references Manager) facilitated the organization of sources, ensured accurate citation, and supported the transparent documentation of the review process.

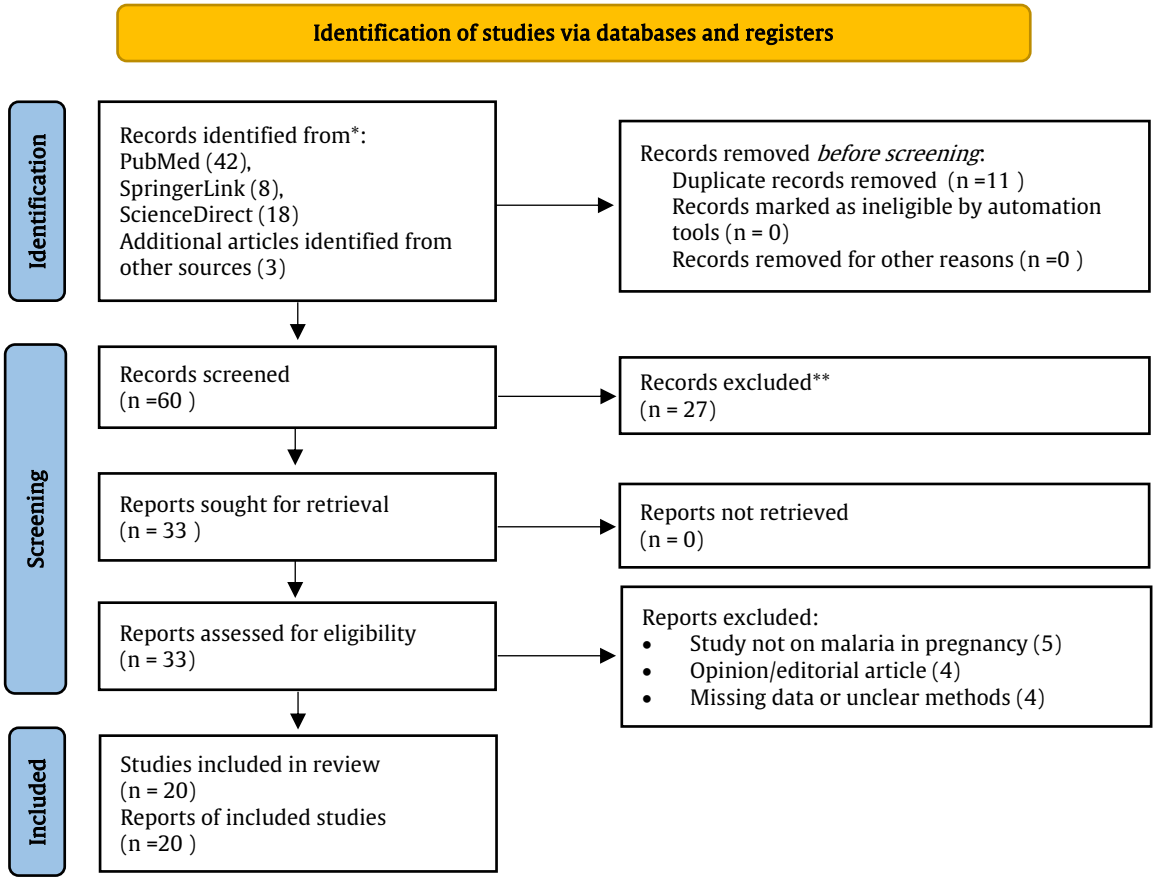

Figure 1. Literature selection process for the present article

RESULTS OF STUDY

Table 1 outlines the maternal health risks, fetal health risks, and prevention and management strategies for malaria during pregnancy, with the strength of evidence assessed using the GRADE approach. This literature review, synthesizing evidence from 20 selected studies, affirms that malaria infection during pregnancy remains a critical threat to maternal and fetal health, with both direct and indirect consequences seen across high-burden regions (See table 2 in Appendix). The general prevalence of malaria in pregnancy, as documented by cohort, cross-sectional, and meta-analytic research, ranges from as low as 0.32% in certain hospital-based studies to almost 19% in global analyses, with the highest burden consistently observed in Africa and among socially vulnerable populations (Das et al., 2024; Ijo Moses, 2024; Palem & Pal, 2019).

Maternal Health Risks

Across most included studies, malaria in pregnancy is strongly associated with an increased risk of maternal anemia, thrombocytopenia, placental malaria, and hypertensive disorders (Harrington et al., 2021; Purwatiningsih et al., 2022; Palem & Pal, 2019; Soomro et al., 2024). For instance, Das et al. (2024) found that the risk of anemia in pregnant women with malaria is more than doubled (OR 2.40, 95% CI: 1.87–3.06), and Palem & Pal (2019) reported anemia in 34.1% of cases and thrombocytopenia in 26.8%. Plasmodium falciparum

infection, in particular, is highlighted as a major risk factor for hypertensive disorders such as preeclampsia and gestational hypertension, especially when infection occurs in the first trimester and among primigravidas (Harrington et al., 2021). Placental malaria is another critical maternal complication, with prevalence reaching as high as 65.9% among primigravidas in high transmission settings (Akinnawo et al., 2022) and 59.3% overall in Blue Nile State, Sudan (Omer et al., 2017). Lack of antenatal care, young maternal age, and low socioeconomic status were consistently found to increase the risk of placental malaria and anemia (Ijo Moses, 2024; Akinnawo et al., 2022; Omer et al., 2017).

Table 1. Comparative synthesis of pregnant women with malaria based on maternal health risks, fetal health risks, prevention and management strategies during pregnancy, and strength of evidence (GRADE).

Category	Outcome / Riks	Strength of Evidence (GRADE)	Summary Description
Maternal Health Risks	Severe anemia	Moderate	Malaria infection leads to the destruction of red blood cells, resulting in significant anemia.
	Placental malaria	Moderate to High	Accumulation of parasites in the placenta impairs the transfer of nutrients and oxygen, contributing to anemia and intrauterine growth restriction (IUGR).
	Severe complications	Moderate	Includes cerebral malaria and pulmonary edema; increases the risk of maternal morbidity and mortality.
	Prolonged fever and malaise	Moderate	Common symptoms that may deteriorate the condition of pregnant women and affect overall well-being.
Fetal Health Risks	Miscarriage	Low to Moderate	Malaria increases the risk of miscarriage due to placental infection.
	Low birth weight (LBW)	High	Malaria infection interferes with fetal nutrition and oxygenation, leading to reduced birth weight.
	Neonatal death	Moderate	The risk of neonatal mortality rises due to pregnancy complications associated with malaria.
	Prematurity	Low to Moderate	Infection may trigger preterm labor, leading to potential complications.
Prevention and Management Strategies	Use of long-lasting insecticidal nets (LLINs)	High	Proven effective in reducing exposure to malaria-transmitting mosquito bites.
	Intermittent preventive treatment in pregnancy (IPTp)	High	Administration of antimalarial drugs at scheduled intervals during pregnancy to prevent infection..
	Early diagnosis and appropriate treatment	Moderate	Prompt detection and effective antimalarial therapy reduce risks for both mother and fetus.

Fetal and Neonatal Risks

Malaria in pregnancy also imposes significant risks on fetal and neonatal outcomes. According to meta-analysis by Das et al. (2024), malaria-infected pregnancies are associated with higher odds of low birth weight (OR 1.99), preterm delivery (OR 1.65), and fetal death (OR 1.40). These findings are reinforced by individual studies: Purwatiningsih et al. (2022) and Berhe et al. (2023) found strong links to low birth weight, preterm birth, small-for-gestational-age infants, and neonatal death. Palem & Pal (2019) observed spontaneous miscarriage in 17%, preterm birth in 21.8%, and low birth weight in 29.1% of cases. The impact is especially marked in the first trimester, as reported by Koladjo et al. (2022), though early detection and treatment can mitigate fetal growth restriction. Infants exposed in utero are also at greater risk of developing malaria and severe infection in infancy (Jagannathan, 2018).

Notably, subgroup analysis shows that primigravidas, women of younger maternal age, those with HIV, and those living in rural or resource-poor settings experience higher rates of both maternal and fetal complications (Akinnawo et al., 2022; Ijo Moses, 2024; Omer et al., 2017). Studies further report regional variations, with Africa carrying a heavier burden compared to Asia (Das et al., 2024), and additional disparities observed between rural and urban settings (Ijo Moses, 2024).

Prevention and Management Strategies

The included literature provides robust evidence supporting current prevention strategies. The use of insecticide-treated nets (ITNs) and intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine (SP) has proven effective in reducing malaria prevalence, increasing maternal hemoglobin levels, and lowering the incidence of placental malaria, preterm births, and low birth weight (Akinnawo et al., 2022; Uwimana, 2024; Loyce, 2024; Gill & Anvikar, 2024; Chua et al., 2021). For example, Loyce (2024) describes IPTp-SP as reducing malaria prevalence and adverse birth outcomes, although challenges persist due to SP resistance, infrastructural limitations, and sociocultural barriers. Community health worker involvement, dihydroartemisinin-piperaquine (DP) as an alternative regimen, and mHealth approaches have been highlighted as promising innovations to improve IPTp coverage and adherence (Loyce, 2024).

Despite these advances, implementation challenges remain a major barrier, especially in resource-constrained areas. Drug resistance, gaps in healthcare access, and socioeconomic determinants all limit the full realization of

preventive interventions (Goyal et al., 2016; Uwimana, 2024; Berhe et al., 2023). Health education and early diagnosis are also repeatedly recommended to improve uptake and impact, particularly for primigravidas and women in their second trimester (Ijo Moses, 2024).

Mechanistic and Long-term Outcomes

Several studies further elaborate on the underlying physiological mechanisms. Placental sequestration of parasites disrupts nutrient and oxygen exchange, leading to fetal growth restriction and adverse outcomes (Chua et al., 2021; Berhe et al., 2023). Wright et al. (2023) provide evidence of intestinal barrier disruption and systemic inflammation with P. falciparum infection, which are linked to preterm birth. Regarding long-term consequences, infants exposed to malaria in utero face up to 3.2 times higher risk of clinical malaria and malaria-related mortality during infancy (Jagannathan, 2018). The ongoing development of malaria vaccines for pregnant women (PAMVAC, PRIMVAC) and the establishment of baseline data for evaluating their safety and efficacy represent a critical research frontier (Berhe et al., 2023; Gill & Anvikar, 2024).

Collectively, these findings highlight that malaria infection during pregnancy continues to pose major risks to both mothers and infants, especially in high-transmission settings and among vulnerable groups. Prevention through ITNs, IPTp, education, and healthcare system strengthening remains key, but persistent challenges call for adaptive strategies and ongoing research.

DISCUSSION

Maternal Health Risks

Malaria during pregnancy is a well-established contributor to a spectrum of maternal health complications, including but not limited to anemia, placental malaria, hypertensive disorders, and severe systemic complications such as cerebral malaria and acute respiratory distress syndrome (ARDS) (Berhe et al., 2023; Das et al., 2024; Kamanzi, 2024). Pregnant women, especially in endemic areas, are biologically predisposed to malaria due to physiological and immunological changes that occur during gestation, which may suppress maternal immunity and facilitate parasite sequestration, particularly in the placenta (Chua et al., 2021; Kamanzi, 2024; Rulisa, 2014). If inadequately managed, malaria infection can also have long-term adverse health effects for mothers, ranging from chronic anemia to increased postpartum morbidity (Kamanzi, 2024; WHO, 2023).

One of the most prevalent complications of malaria during pregnancy is severe anemia. The destruction of red blood cells by Plasmodium parasites, compounded by inflammatory responses, leads to a significant drop in hemoglobin levels (Kamanzi, 2024; Das et al., 2024; Sharief et al., 2024). According to Nuzula, Rahardjo, and Murti (2020), pregnant women with malaria have a 1.72-fold increased risk of developing anemia compared to those uninfected (AOR 1.72; 95% CI: 1.43–2.07). Meta-analytic evidence indicates that malaria in pregnancy raises the risk of anemia up to 2.40 times (Das et al., 2024). The etiology of anemia in these women often includes hemolysis, nutritional deficiencies (iron, folate, vitamin B12), and immune-mediated destruction of erythrocytes (Loyce, 2024; Umeanaeto et al., 2022). Mean hemoglobin levels frequently fall below the clinical threshold of 11 g/dL (Umeanaeto et al., 2022). Notably, anemia is a major contributor to maternal morbidity and is often normocytic in type (Sharief et al., 2024).

Placental malaria, defined as the accumulation of Plasmodium-infected erythrocytes within the intervillous spaces of the placenta, is a hallmark complication with significant repercussions for both mother and fetus (Berhe et al., 2023; Chua et al., 2021). This phenomenon disrupts maternal–fetal nutrient and oxygen transfer, resulting in intrauterine growth restriction (IUGR), low birth weight (LBW), and increased risk of fetal demise (Kamanzi, 2024; Das et al., 2024). The inflammation and impaired vascularization associated with placental sequestration are key mechanisms underlying these adverse outcomes (Chua et al., 2021; Weckman et al., 2018). Large cohort and case-control studies, such as those by Akinnawo et al. (2022) and Omer et al. (2017), have demonstrated that primigravidas are especially at risk, with up to threefold higher odds of placental malaria compared to multigravidas. Additional risk factors include young maternal age, lack of antenatal care, and failure to use insecticide-treated nets (Akinnawo et al., 2022; Omer et al., 2017).

Severe malaria in pregnancy can progress to life-threatening complications such as cerebral malaria, ARDS, nephrotic syndrome, hyperparasitemia, and metabolic disorders, including hypoglycemia (Gill & Anvikar, 2024; Kamanzi, 2024; Yagnik et al., 2019). These complications are predominantly associated with Plasmodium falciparum infection and often present more severely in pregnant women due to immunological alterations during gestation (Kamanzi, 2024; Sharma et al., 2024). For example, McKinney et al. (2020) described cases where malaria led to acute renal failure and pulmonary edema, particularly among women with delayed diagnosis or treatment. These conditions contribute substantially to the high maternal mortality rates observed in endemic regions (Kamanzi, 2024; WHO, 2023).

Persistent fever and malaise, hallmarks of malaria infection, also pose additional risks in pregnancy, potentially exacerbating maternal fatigue, nutritional deficits, and dehydration (Matta et al., 2024). The clinical presentation can sometimes mimic other obstetric complications such as HELLP syndrome, complicating diagnosis and management (Ducarme et al., 2010). Thrombocytopenia, another frequent hematologic abnormality, further increases the risk of bleeding and poor outcomes in pregnancy, particularly among primigravidae (Matta et al., 2024). Collectively, these findings emphasize that malaria in pregnancy is not only a major cause of direct morbidity and mortality but also indirectly contributes to a cycle of poor maternal health, poor pregnancy outcomes, and persistent intergenerational health inequities (Berhe et al., 2023; Das et al., 2024; WHO, 2023).

Fetal Health Risks

Malaria during pregnancy significantly elevates the risk of adverse fetal outcomes, including low birth weight (LBW), preterm birth, miscarriage, and neonatal death (Das et al., 2024; Berhe et al., 2023). These risks are most pronounced in regions with intense malaria transmission and among populations with limited access to antenatal care (Chua et al., 2021; Koladjo et al., 2022). The pathophysiological basis for these complications primarily involves placental malaria, whereby Plasmodium-infected

erythrocytes sequester in the placental intervillous spaces, disrupting the normal exchange of nutrients and oxygen between mother and fetus (Chua et al., 2021; Berhe et al., 2023). Inflammation at the maternal-fetal interface, compounded by maternal anemia and nutritional deficiencies, exacerbates these adverse outcomes (Das et al., 2024; Weckman et al., 2018; Kamanzi, 2024).

Miscarriage is a critical concern in malaria-endemic areas, particularly when infection occurs during the first trimester. Studies from Africa and Asia consistently report that both symptomatic and asymptomatic malaria infections increase the risk of spontaneous miscarriage (Matta et al., 2024; Satapathy et al., 2024). Gaoussou et al. (2022) highlighted that the majority of miscarriages associated with malaria occur in the first trimester, a period of heightened vulnerability due to early placental development. The study by Matta et al. (2024) reinforces this finding, reporting a 14% rate of spontaneous miscarriage, all in the first trimester among infected women. Importantly, even subclinical (asymptomatic) infections may compromise fetal viability, underscoring the need for routine malaria screening and early intervention (Satapathy et al., 2024).

Low birth weight is one of the most frequent and well-documented fetal complications of malaria in pregnancy. Das et al. (2024) reported that pregnant women with malaria are nearly twice as likely (OR 1.99) to deliver LBW infants compared to uninfected women. This association is attributed to intrauterine growth restriction (IUGR), which results from impaired placental perfusion, local inflammatory responses, and reduced nutrient transport (Chua et al., 2021; Weckman et al., 2018). Placental malaria promotes the secretion of pro-inflammatory cytokines and the accumulation of immune cells, leading to oxidative stress, apoptosis, and compromised placental vascularization (Sharma & Shukla, 2017). Studies have also noted that the sequestration of Plasmodium falciparum-infected erythrocytes may directly inhibit angiogenesis, further impairing fetal growth (Chua et al., 2021). Evidence from Purwatiningsih et al. (2022) and Berhe et al. (2023) confirms the persistent risk of LBW and small-for-gestational-age infants in malaria-exposed pregnancies, particularly among primigravidas and in resource-poor settings.

Preterm birth is another substantial risk for fetuses exposed to malaria during gestation. Meta-analyses show that the odds of preterm delivery are increased by 65% in pregnancies complicated by malaria (Das et al., 2024). Inflammatory responses and placental insufficiency are recognized as the main drivers of preterm labor (Chua et al., 2021). Recent mechanistic studies, such as Wright et al. (2023), have shown that malaria-related disruption of the intestinal barrier may further enhance systemic inflammation, thereby increasing the likelihood of early labor. The cumulative effect of chronic placental inflammation, maternal anemia, and suboptimal fetal nutrient supply compounds the risk of preterm birth, particularly in women with limited access to antenatal surveillance (Uwimana, 2024; Koladjo et al., 2022).

Neonatal death and stillbirth represent the most severe fetal complications of malaria in pregnancy. The risk of fetal death is 1.4 times higher among malaria-infected women, according to global meta-analyses (Das et al., 2024). This increased risk is strongly linked to severe placental malaria, maternal anemia, and critical reductions in fetal oxygen and nutrient supply (Kamanzi, 2024; Omer et al., 2017). Fetal demise is more likely when malaria occurs in the first or second trimester, or when maternal infection is not promptly detected and treated (Gaoussou et al., 2022; Palem & Pal, 2019). The risk of perinatal mortality is further elevated among infants born to primigravidas, women with HIV co-infection, and those living in rural or socioeconomically disadvantaged areas (Akinnawo et al., 2022; Ijo Moses, 2024).

Emerging evidence suggests that the consequences of in utero malaria exposure extend beyond birth. Infants born to mothers with malaria during pregnancy have an increased susceptibility to malaria and other infectious diseases during infancy, with studies reporting a relative risk increase of 1.5 to 3.2 times (Jagannathan, 2018). Chronic health issues, such as impaired immune development, stunted growth, and delayed neurodevelopment, have also been documented, especially among those with low birth weight or preterm delivery histories (Jagannathan, 2018; Berhe et al., 2023).

Fetal risks are not uniformly distributed but vary significantly across geographic regions, subpopulations, and malaria species. The burden of adverse outcomes is disproportionately higher in sub-Saharan Africa compared to Southeast Asia (Das et al., 2024), and within countries, rural and impoverished communities bear the greatest risk (Ijo Moses, 2024; Omer et al., 2017). Primigravidas and adolescents are particularly vulnerable due to lack of immunity and limited access to antenatal care (Akinnawo et al., 2022; Koladjo et al., 2022). In addition, Plasmodium falciparum infections are more likely to result in severe fetal complications than P. vivax, underscoring the importance of species-specific prevention and management strategies (Harrington et al., 2021; Matta et al., 2024).

Prevention and Management Strategies

Preventing and managing malaria during pregnancy is crucial in reducing the burden of maternal and fetal morbidity and mortality. The World Health Organization (WHO) recommends a comprehensive strategy, including intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine (SP), the widespread use of insecticide-treated nets (ITNs), early and accurate diagnosis, and timely, effective treatment (Uwimana, 2024; Gill & Anvikar, 2024; WHO, 2023). Implementation of these approaches has led to significant reductions in malaria incidence and complications in pregnant women across endemic regions, but gaps remain due to health system, behavioral, and biological challenges.

IPTp with SP remains a cornerstone of malaria prevention in pregnancy, especially in sub-Saharan Africa. This intervention is associated with reduced malaria prevalence, increased maternal hemoglobin, lower incidence of placental malaria, preterm births, and low birth weight infants (Loyce, 2024; Akinnawo et al., 2022; Berhe et al., 2023). However, the effectiveness of IPTp is threatened by rising SP resistance, limited access to antenatal care, inconsistent drug supply, and cultural barriers affecting adherence (Loyce, 2024; Uwimana, 2024; Kojom Foko & Singh, 2023). The engagement of community health workers and alternative regimens such as dihydroartemisinin-piperaquine (DP) have been suggested as promising strategies to enhance IPTp uptake and overcome resistance (Loyce, 2024; Gill & Anvikar, 2024). Furthermore, mobile health (mHealth) interventions are increasingly used to support adherence and education (Loyce, 2024).

The use of ITNs is a well-established, cost-effective primary preventive measure. Consistent ITN use has been shown to reduce malaria incidence by up to 50% among pregnant women (Gill & Anvikar, 2024; Yulizawati et al.,

2023). ITNs not only reduce the risk of infection but also lower the probability of severe complications and adverse birth outcomes such as low birth weight and stillbirth (Akinnawo et al., 2022; Berhe et al., 2023). Nevertheless, socioeconomic challenges–such as affordability, awareness, and behavioral factors–limit ITN coverage and consistent use, especially in rural and low-income settings (Yulizawati et al., 2023; Uwimana, 2024). Community-based distribution and educational campaigns have shown potential to improve ITN adoption (Yulizawati et al., 2023).

Early and accurate diagnosis, using rapid diagnostic tests (RDTs) or microscopy, followed by timely treatment, is essential to minimize the risk of maternal and fetal complications (Office, 2022; Goyal et al., 2016). Artemisinin-based combination therapies (ACTs) are recommended for uncomplicated malaria in the second and third trimesters due to their high efficacy and safety profile (Office, 2022; WHO, 2023). However, ACTs are used cautiously in the first trimester because of limited safety data, and quinine-based regimens remain the first-line option in early pregnancy (Goyal et al., 2016). Ensuring the availability of effective drugs and diagnostic tools at all healthcare levels is vital for optimal management.

Health education programs targeting pregnant women, families, and communities are key to increasing awareness about the risks of malaria and the benefits of preventive measures (Ijo Moses, 2024; Uwimana, 2024). Education can improve ITN usage, encourage early antenatal care attendance, and promote adherence to IPTp regimens. Successful examples include community-led campaigns and integration of malaria education into routine antenatal services (Uwimana, 2024).

Additional strategies such as indoor residual spraying, larval source management, and nutritional interventions are recommended to complement core interventions, especially in high-transmission areas (Uwimana, 2024; Hamlet et al., 2022). Research into malaria vaccines for pregnant women (e.g., PAMVAC, PRIMVAC) is ongoing, with the goal of providing an additional layer of protection (Berhe et al., 2023). Addressing system-level barriers–such as healthcare worker training, logistics, and surveillance–is critical for improving the reach and sustainability of all preventive measures (Gill & Anvikar, 2024; Koffi et al., 2023).

In addition to the well-established mechanisms of placental malaria, recent research has highlighted the significant role of intestinal barrier disruption in the pathogenesis and adverse outcomes of malaria during pregnancy. Wright et al. (2023) demonstrated that Plasmodium falciparum infection can increase maternal gut permeability, as indicated by elevated levels of sCD14 and LBP, markers of microbial translocation and systemic inflammation. This disruption in gut barrier integrity is associated with higher systemic inflammation, which, in turn, is linked to an increased risk of preterm birth. Such findings expand our understanding of malaria pathophysiology during pregnancy beyond placental sequestration and suggest that restoring gut barrier function could be a novel therapeutic target (Wright et al., 2023; Di Vincenzo et al., 2022). Further, this mechanistic insight is reinforced by studies that connect gut dysbiosis and immune modulation to adverse pregnancy outcomes in other infectious diseases, supporting the notion that maternal gut health plays a critical role in fetal development (Sajdel-Sulkowska, 2023; Abu & Roy, 2025).

On the frontier of prevention, the development of vaccines specifically designed for pregnant women represents a transformative advance in the fight against maternal malaria. The PAMVAC and PRIMVAC vaccine candidates, which target the VAR2CSA protein responsible for placental adhesion of P. falciparum, have shown promise in early clinical trials for generating robust immune responses and are undergoing further evaluation for safety and efficacy (Berhe et al., 2023; Chêne et al., 2016; Ataide et al., 2014). Recent progress in mRNA and nanoparticle vaccine technologies also opens new avenues for more effective immunization strategies (Ho et al., 2021; Healer et al., 2017). Importantly, the establishment of reliable baseline pregnancy outcome data is essential for the rigorous assessment of vaccine effectiveness and monitoring for rare adverse effects (Berhe et al., 2023; Gill & Anvikar, 2024).

Collectively, these advances underscore that malaria in pregnancy continues to pose substantial health risks to both mothers and infants, especially in high-transmission regions and among vulnerable populations. While ITNs, IPTp, and early treatment remain central to current prevention strategies, future progress will depend on innovative approaches such as gut-targeted therapies, advanced vaccines, and integrated maternal-child health interventions. Ongoing investment in translational research, clinical trials, and surveillance will be key to overcoming persistent challenges and achieving substantial reductions in maternal and perinatal malaria morbidity and mortality (World Health Organization, 2023; Ataide et al., 2014; Ho et al., 2021).

Policy Gaps, Future Directions, Limitations

Despite global progress, this review identifies persistent gaps between global evidence and national responses, particularly in countries like Indonesia, where malaria remains a substantial public health challenge. Strengthening policy advocacy, integrating evidence-based interventions, and tailoring strategies to address local barriers are critical (Uwimana, 2024; Gill & Anvikar, 2024). Continuous research on malaria vaccines for pregnancy, diagnostic technologies, and long-term infant outcomes is warranted to advance prevention and management efforts (Berhe et al., 2023; Gill & Anvikar, 2024).

This review is limited by the heterogeneity of study designs, populations, and regional contexts among included articles, which may affect the generalizability of certain findings. Despite strict quality appraisal and selection criteria, publication bias and gaps in available data–particularly from low-resource settings–remain challenges. Future research should prioritize large-scale, high-quality cohort studies and intervention trials in diverse settings.

CONCLUSION AND RECOMMENDATION

Malaria infection during pregnancy remains a significant contributor to maternal and fetal morbidity and mortality, especially in high-transmission regions and among socioeconomically disadvantaged populations. This review found robust evidence–ranging from meta-analyses to large-scale observational studies–that maternal risks include severe anemia (OR 2.40, 95% CI: 1.87–3.06; GRADE: high), placental malaria (up to 65.9% among primigravidas in high-transmission areas), and life-threatening complications such as cerebral malaria and acute respiratory distress syndrome (Berhe et al., 2023; Das et al., 2024; Harrington et al., 2021; Akinnawo et al., 2022). For fetal health, malaria is associated with a significantly higher risk of low birth weight (OR 1.99, 95% CI: 1.60–2.48;

GRADE: high), preterm birth (OR 1.65, 95% CI: 1.29–2.10), miscarriage, and neonatal death (Das et al., 2024; Berhe et al., 2023). These findings confirm the urgent need for continued and enhanced preventive measures.

To the government and policy makers, the evidence strongly supports strengthening malaria surveillance, universal access to insecticide-treated nets (ITNs) and intermittent preventive treatment in pregnancy (IPTp), especially in areas of high transmission. Policies should prioritize early detection, ensure continuous drug supply, and support robust health system infrastructure for rapid response. Investments in healthcare worker training, community education, and the development of digital health tools (such as mHealth interventions) can significantly enhance coverage and adherence to preventive interventions (Uwimana, 2024; Loyce, 2024). Special focus must be placed on addressing geographic and social disparities, with additional resources allocated for marginalized groups, including adolescents, rural populations, and women with limited access to antenatal care.

For practitioners and healthcare providers, early and accurate diagnosis using rapid diagnostic tests (RDTs), followed by the prompt initiation of appropriate antimalarial therapy (e.g., artemisinin-based combination therapies for the 2nd/3rd trimesters), is crucial to mitigate adverse outcomes. Practitioners should proactively provide education to pregnant women and their families about the importance of ITN use, adherence to IPTp regimens, and seeking timely antenatal care, especially during the first trimester when risks are highest (Gill & Anvikar, 2024; Matta et al., 2024). Interdisciplinary collaboration between obstetric, infectious disease, and community health teams is essential to deliver integrated care and support.

For the research community, there is an urgent need for further studies on the effectiveness and safety of new malaria vaccines for pregnant women, improvements in diagnostic technologies, and longitudinal monitoring of long-term child health outcomes post-exposure. Special attention should be paid to evaluating the real-world implementation of innovative prevention strategies, such as gut barrier-targeted therapies and advanced vaccine technologies (Wright et al., 2023; Berhe et al., 2023; Ataide et al., 2014). Large-scale, high-quality cohort studies and pragmatic clinical trials are recommended, especially in underrepresented regions and among high-risk subpopulations.

For cross-sector stakeholders–including those in education, social services, and community empowerment–multi-sectoral collaboration is vital to address the socioeconomic and cultural barriers that limit access to malaria prevention and care. Programs should be designed to increase health literacy, support women's empowerment, and provide social protection for vulnerable families (Yulizawati et al., 2023). Public-private partnerships and integration of malaria prevention into broader maternal and child health platforms can maximize impact.

Urgency for further action and research is highlighted by the persistent gaps between global evidence and local practice, particularly in Indonesia and other high-burden Southeast Asian nations. Surveillance systems need enhancement, with real-time data used to inform adaptive policy and programmatic decisions. Monitoring drug and insecticide resistance trends is critical, as is ensuring equitable access to new technologies as they become available (Koffi et al., 2023; Gill & Anvikar, 2024). Vaccine research must be accelerated with local trials to determine context-specific efficacy, and innovative approaches to implementation must be documented and scaled.

Despite rigorous quality assessment and broad database searches, this review acknowledges several limitations. These include the heterogeneity of included studies, publication bias, and limited data from certain low-resource settings, which may restrict generalizability. Future reviews should focus on systematic inclusion of unpublished and non-English studies and further evaluate intervention effectiveness in real-world settings. In summary, this manuscript contributes significantly to the scientific understanding and practical guidance on malaria in pregnancy by synthesizing evidence on health risks, prevention, and implementation challenges. It serves as a critical tool for advocacy, policy strengthening, and capacity building in developing countries facing the greatest burden. Stronger multisectoral actions, targeted research, and health system investments are urgently needed to protect the health of mothers and infants, reduce health inequities, and move toward the elimination of malaria as a threat to maternal and child health.

DECLARATIONS

Competing Interests

The author declares no competing interests.

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Availability of Data and Materials

All data supporting the findings of this study are included in this manuscript. Additional data may be provided by the corresponding author upon reasonable request.

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ADDITIONAL INFORMATION

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APPENDIX

Table 2. Journal characteristics based on author, year, study title, methode and results

No	Researcher (Year)	Title	Methode	Result
1	Harrington et al. (2021)	Falciparum but not vivax malaria increases the risk of hypertensive disorders of pregnancy	A prospective cohort of 23,262 pregnancies on the Thailand–Myanmar border	First-trimester Plasmodium falciparum infection increases the risk of preeclampsia and gestational hypertension, particularly among primigravidas.
2	Koladjo et al. (2022)	Malaria in the First Trimester of Pregnancy and Fetal Growth	A prospective cohort of 411 pregnant women in Benin, using serial ultrasound examinations	No significant association was found between first-trimester malaria and fetal growth restriction, as early treatment reduces its impact.
3	Purwatiningsih et al. (2022)	Prevalence and Impact of Malaria Infection in Pregnant Women and Neonates	A systematic review was conducted using the PubMed and ScienceDirect databases, with 10 articles included in the analysis.	Malaria infection during pregnancy is associated with maternal anemia, preterm birth, low birth weight (LBW), small-for-gestational-age (SGA) infants, and neonatal death.
4	Ijo Moses (2024)	Prevalence and Socio-demographic Characteristics of Malaria in Pregnancy among Women Attending Antenatal Care in Fort Portal Regional Referral Hospital, Uganda	A descriptive cross-sectional study design involving 400 pregnant women attending antenatal clinics. Data were collected using structured questionnaires and analyzed using SPSS. The study assessed the prevalence of malaria and its association with socio-demographic factors.	The prevalence of malaria in pregnancy was 7.8%. Higher risk was observed among women aged 24–45 years, with low education levels, unemployed or self-employed status, primigravidas, and those in their second trimester. Infection rates were also higher among urban residents and those living in semi-permanent or temporary housing. Recommendations include enhancing health education and increasing the distribution of insecticide-treated nets, particularly for primigravidas and women in their second trimester.
5	Goyal, Sehgal, Gautam & Sehgal (2016)	Malaria in Pregnancy	A comprehensive literature review on malaria in pregnancy, covering disease burden, pathogenesis, diagnosis, risk factors, immune response, maternal and fetal impacts, as well as prevention and treatment strategies.	Pregnancy increases the risk of malaria by up to fourfold and doubles the risk of mortality. Malaria during pregnancy leads to anemia, preterm birth, low birth weight, and neonatal death. Diagnosis is often challenging, as parasites frequently sequester in the placenta. Prevention strategies such as insecticide-treated nets (ITNs), intermittent preventive treatment (IPT), and effective case management have proven beneficial. However, drug resistance presents new challenges, necessitating further research on artemisinin-based combination therapies and molecular diagnostic approaches such as PCR and LAMP.
6	Palem & Pal (2019)	Maternal and fetal outcome of malaria in pregnancy	A prospective observational study was conducted at Lady Goschen Hospital, Mangalore, from September 2014 to September 2015. It involved 41 pregnant women diagnosed with malaria through rapid diagnostic tests or microscopy. Data were collected from outpatient records, case sheets, and delivery notes.	The prevalence of malaria in pregnancy was 0.32%. Plasmodium vivax was the predominant pathogen (63%). Maternal complications included anemia (34.1%) and thrombocytopenia (26.8%). Fetal complications included spontaneous miscarriage (17%), preterm birth (21.8%), low birth weight (29.1%), and perinatal death (2.4%). Plasmodium falciparum was more frequently associated with miscarriage and perinatal death compared to P. vivax. Malaria screening is recommended for all pregnant women presenting with fever to improve pregnancy outcomes..
7	Berhe, Doritchamou & Duffy (2023)	Malaria in pregnancy: adverse pregnancy outcomes and the future of prevention	A literature review (mini review) summarizing key findings on the impact of malaria in pregnancy (MiP) on pregnancy outcomes, and discussing prevention strategies, including vaccine development for MiP.	MiP (Malaria in Pregnancy) increases the risk of miscarriage, preterm birth, intrauterine growth restriction (IUGR), low birth weight (LBW), and perinatal death. Plasmodium falciparum infection leads to placental malaria, triggering inflammation and impaired placental perfusion. Preventive interventions such as insecticide-treated nets (ITNs), intermittent preventive treatment in pregnancy (IPTp), and potential vaccination can reduce the adverse outcomes of MiP. Two vaccine candidates, PAMVAC and PRIMVAC,

				are currently under development. Establishing baseline pregnancy outcome data is essential for evaluating the safety and efficacy of these vaccines in future clinical trials.
8	Gill & Anvikar (2024)	New Strides in Prevention of Malaria during Pregnancy Present Multitudinous Opportunities	A literature review analyzing global progress in malaria prevention strategies during pregnancy, with a focus on key interventions recommended by the WHO.	Malaria during pregnancy increases the risk of serious complications for both mother and fetus, including anemia, hypoglycemia, cerebral malaria, pulmonary edema, and puerperal sepsis. The World Health Organization (WHO) recommends three main interventions: intermittent preventive treatment in pregnancy (IPTp), the use of insecticide-treated nets (ITNs), and effective case management with therapeutic antimalarial drugs. This article also discusses community-based approaches to IPTp (c-IPTp), intermittent screening and treatment in pregnancy (ISTp), the development of malaria vaccines for pregnant women, and additional factors critical to improving prevention outcomes. Despite the global decline in malaria cases, malaria in pregnancy remains a significant concern in endemic areas, requiring strengthened prevention strategies.
9	Matta, Kundaram, Bhavishya & Manoj (2024)	An epidemiological study assessing maternal and fetal outcome of malaria in pregnancy: An observational study	An observational study was conducted over one year in a hospital in India. Out of 12,500 pregnant women, 50 were diagnosed with malaria. Diagnosis was based on clinical examination, rapid diagnostic tests (RDTs), and blood smear microscopy for Plasmodium species identification. Data were collected from medical records and analyzed descriptively.	The incidence of malaria in pregnancy was 0.40%, with the highest occurrence in primigravidas (64%). Plasmodium vivax was the dominant pathogen (58%), followed by P. falciparum (24%) and mixed infections (18%). Maternal complications included anemia (38%) and thrombocytopenia (32%). Fetal complications included spontaneous miscarriage (14%, all in the first trimester), preterm birth (22%), low birth weight (30%), and perinatal death (2%). It is concluded that malaria has a negative impact on both maternal and fetal outcomes, and malaria screening in pregnant women presenting with fever is highly recommended.
10	Soomro, S., Shaikh, A. A., Hafeez, R., Memon, S. A., & Lakhan, H. (2024)	Impact of Malaria in Pregnancy on Maternal and Fetal Health Among Flood-Affected Patients at GMC Sukkur	Cross-sectional descriptive study among pregnant women affected by floods and diagnosed with malaria at GMC Sukkur, Pakistan	Plasmodium vivax was identified in 90.2% of cases. Maternal anemia occurred in 76.2% of women, primarily among those infected with P. vivax (67.2%, p=0.331). Thrombocytopenia was present in 48.4% and significantly associated with P. vivax (40.2%, p=0.020). Preterm labor (16.4%, p=0.538), low birth weight (16.4%, p=0.515), and intrauterine fetal death (4.1%, p=0.001) were also reported.
11	Jagannathan, P. (2018)	How does malaria in pregnancy impact malaria risk in infants	Commentary and synthesis of recent studies discussing the relationship between malaria during pregnancy and infant malaria susceptibility	The reviewed studies indicate that infants exposed to malaria in utero face a significantly higher risk of developing clinical malaria during their first year of life. For example, several studies report an increased relative risk (RR) ranging from 1.5 to 3.2 times compared to infants not exposed during pregnancy. Additionally, the risk of severe infection and malaria-related mortality is also elevated among infants born to mothers with malaria during pregnancy. These statistical findings highlight the critical importance of malaria prevention and treatment during pregnancy to reduce the risk of malaria in infants.
12	Kamanzi Nyirabashitsi I. (2024)	Clinical Manifestations and Health Impact of Malaria in Pregnant Women	Comprehensive literature review	Malaria in pregnant women causes anemia, fetal growth restriction, preterm labor, and low birth weight. Placental infection disrupts nutrient transfer to the fetus. The risk is higher among women with HIV and those from low socioeconomic backgrounds. Effective prevention includes preventive treatment, insecticide-treated bed nets, and access to healthcare services.
13	Das, J. K., et.al (2024)	Malaria in Pregnancy: Meta-Analyses of Prevalence and Associated Complications	A meta-analysis of 253 global studies on the prevalence of malaria in pregnancy and associated complications	The overall prevalence of malaria in pregnancy was 18.95% (95% CI: 16.95–21.11). The highest prevalence was observed in Africa, with rates of 21.50% during antenatal visits and 20.41% at delivery. The risk of complications in pregnant women with malaria increased significantly: anemia (OR 2.40; 95% CI: 1.87–3.06), low birth weight (OR 1.99; 95% CI: 1.60–2.48), preterm delivery (OR 1.65; 95% CI: 1.29–2.10), and fetal death (OR 1.40; 95% CI: 1.15–1.71).

14	Akinnawo et al., (2022)	Assessing the relationship between gravidity and placental malaria among pregnant women in a high transmission area in Ghana	A secondary data analysis of a cohort study conducted in Kintampo, Ghana, involving 1,808 pregnant women	The prevalence of placental malaria (PM) was 65.9% among primigravidas (PG), 44.6% among secundigravidas (SG), and 26.5% among multigravidas (MG). After adjusting for age, socioeconomic status, and relationship status, PGs had an odds ratio (OR) of 3.36 (95% CI: 2.39–4.71) compared to MGs. The risk of PM was higher among PGs living in rural areas (OR 3.79) and those with low socioeconomic scores (OR 4.73). The use of insecticide-treated nets (ITNs) and intermittent preventive treatment with sulfadoxine-pyrimethamine (IPTp-SP) reduced the risk of PM among primigravidas.
15	Omer, et al., (2017)	Placental malaria and its effect on pregnancy outcomes in Sudanese women from Blue Nile State	A cross-sectional hospital-based study conducted in three major hospitals in Blue Nile State, Sudan, from January 2012 to December 2015, involving 1,149 pregnant women and their newborns.	The prevalence of placental malaria was 59.3%, with Plasmodium falciparum as the only species detected. Significant risk factors for placental malaria included age ≤23.2 years (AOR = 3.2; 95% CI: 1.9–5.5), primigravidity (AOR = 3.9; 95% CI: 2.1–7.6), lack of antenatal care visits (AOR = 11.9; 95% CI: 7.8–18.1), and non-use of insecticide-treated nets (AOR = 3.5; 95% CI: 1.7–6.8). Placental malaria was significantly associated with maternal anemia (AOR = 41.6; 95% CI: 23.3–74.4) and low birth weight (AOR = 25.2; 95% CI: 15.1–41.3).
16	Yagnik et al., 2019	Severe Case of Plasmodium falciparum Malaria in a Pregnant Woman from Nigeria	Case report of a 28-year-old pregnant Nigerian woman with 9.8% parasitemia	The patient was admitted to the ICU and initially treated with oral clindamycin/quinine, followed by a switch to intravenous artesunate. After four doses of IV artesunate, parasitemia cleared, and the patient recovered without further complications. A three-day follow-up treatment with artemether/lumefantrine was administered.
17	Chua et al., 2021	Poor Birth Outcomes in Malaria in Pregnancy: Recent Insights Into Mechanisms and Prevention Approaches	A Literature Review on the Mechanisms and Preventive Approaches of Malaria in Pregnancy	Malaria during pregnancy, particularly infections caused by Plasmodium falciparum, can lead to low birth weight (LBW) and preterm delivery. This infection disrupts placental function through inflammation and impaired vascular development, affecting the transport of nutrients and oxygen to the fetus. Effective preventive interventions include the use of insecticide-treated bed nets, intermittent preventive therapy with sulfadoxine-pyrimethamine, and vaccination, which is currently undergoing clinical trials. Further research is needed to better understand the pathophysiological mechanisms and to develop improved prevention strategies.
18	Wright et al., 2023	Intestinal barrier disruption with Plasmodium falciparum infection in pregnancy and risk of preterm birth: a cohort study	Data analysis from 1,339 HIV-negative pregnant women in Malawi with gestational age less than 24 weeks	Pregnant women with P. falciparum infection exhibit higher plasma concentrations of sCD14 and LBP, which are associated with an increased risk of preterm birth (OR 2.67 for sCD14 and 1.63 for LBP). Disruption of the gut barrier is linked to elevated systemic inflammation and impaired angiogenesis. Moreover, sCD14 levels are inversely associated with the availability of L-arginine, a key molecule for maintaining gut barrier integrity and supporting placental development.
19	Uwimana (2024)	Overview of Malaria in Pregnancy: Challenges and Strategies for Effective Prevention	Literature Review on the Challenges and Prevention Strategies of Malaria in Pregnancy	Malaria in pregnancy remains a significant public health issue in sub-Saharan Africa, with 30 million pregnancies at risk each year. Pregnant women are particularly vulnerable due to immunological changes and a placental environment that facilitates parasite sequestration. Effective prevention strategies include the use of insecticide-treated nets (ITNs) and intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine. However, adherence to chemoprevention remains challenging due to side effects and socioeconomic barriers. Health education programs are essential to improve awareness and preventive behaviors. Early diagnosis and prompt treatment are critical for managing severe malaria cases. Vector control measures, such as indoor residual spraying and larval source management, are vital for reducing mosquito populations and transmission. Nutritional interventions also support immune function and overall health. Access to healthcare services, innovative technologies, and consideration of cultural and socioeconomic factors are crucial for overcoming barriers to malaria prevention and treatment. Continuous monitoring and evaluation are needed to refine interventions and improve health outcomes.

20	Loyce, N. (2024)	Assessing the Impact of Intermittent Preventive Treatment in Reducing Malaria Incidence among Pregnant Women in High-Risk Areas	A Literature Review on the Effectiveness of IPTp-SP in Reducing Malaria Incidence Among Pregnant Women in High-Endemic Areas	IPTp-SP has proven effective in reducing malaria prevalence, increasing maternal hemoglobin levels, and decreasing the incidence of placental malaria and preterm births. However, challenges such as sulfadoxine-pyrimethamine (SP) resistance, limited healthcare infrastructure, and sociocultural barriers hinder its implementation. Alternatives such as dihydroartemisinin-piperaquine (DP), the involvement of community health workers, and mobile health (mHealth) technologies may enhance IPTp coverage and adherence..