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Dynamics and Literature Review of Malaria Cases in Indonesia in the Development of Diagnosis and Management in 2020-2025

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ABSTRACT

Malaria remains a major public health problem in Indonesia, especially in eastern provinces such as Papua and West Papua. The period 2020–2025 is critical because it combines the national malaria elimination program with disruptions to health services during the COVID-19 pandemic. Understanding trends in diagnosis and clinical management is important to strengthen national strategies. This systematic review summarizes evidence on malaria trends in Indonesia from 2020 to 2025, focusing on diagnostic developments and treatment practices. A systematic search was conducted in PubMed, Scopus, Google Scholar, ScienceDirect, SINTA, and Garuda using keywords such as "malaria," "Indonesia," "diagnosis," "management," "RDT," "microscopy," "PCR," and "ACT." Articles published between January 2020 and February 2025 were screened using PRISMA guidelines. Studies were included if they reported malaria incidence, diagnostic methods, treatment strategies, or surveillance outcomes in Indonesia. Of 1,182 records identified, five studies met the final inclusion criteria. Data were extracted and analyzed narratively. The findings show that microscopy remains the gold standard for malaria diagnosis. However, its effectiveness is limited by uneven distribution of trained personnel and laboratory capacity. Rapid Diagnostic Tests (RDTs) are increasingly used in remote areas because they are practical and easy to use, although their sensitivity decreases in cases with low parasite levels. Polymerase Chain Reaction (PCR) offers better detection of low-density and mixed infections, but its use is largely restricted to research centers and tertiary laboratories. For treatment, Artemisinin-based Combination Therapy (ACT) remains the main therapy for uncomplicated malaria, while intravenous artesunate is the first-line treatment for severe cases. Across the reviewed studies, early diagnosis, appropriate use of antimalarial drugs, and reduction of mosquito exposure were consistently linked to better outcomes. Screening of students from endemic areas who were studying in non-endemic provinces did not detect asymptomatic malaria cases. Overall, the review shows both progress and ongoing challenges. Diagnostic capacity has improved, but regional disparities remain. Strengthening laboratory skills, better integrating RDT, microscopy, and PCR approaches, and improving surveillance and referral systems are essential to reach the 2030 malaria elimination target. Future research should focus on monitoring treatment response, mapping drug resistance, and evaluating the implementation of diagnostic strategies.

INTRODUCTION

Malaria is a mosquito-borne infectious disease caused by protozoan parasites of the genus Plasmodium, with the most frequently identified species being Plasmodium falciparum, P. vivax, P. ovale, and P. malariae (UNICEF, 2022). Transmission occurs primarily through the bite of an

infected female Anopheles mosquito, and initial symptoms commonly resemble influenza-like manifestations including fever, headache, chills, and vomiting, typically appearing within 10 to 28 days after exposure (Prabowo, 2004; Ogunah et al., 2020). Historically, malaria has been recognized as a major public health concern with significant clinical and socio-economic impact, leading to global efforts to reduce morbidity and mortality (Garrido-Cardenas et al., 2019).

Globally, malaria mortality has shown substantial fluctuations over the last two decades. The World Malaria Report documented a reduction in deaths from 887,000 cases in 2000 to 568,000 in 2019; however, the COVID-19 pandemic resulted in an increase to 625,000 deaths in 2020 due to disruptions in diagnostic and clinical services (Taek et al., 2019; WHO, 2021). Southeast Asia contributed approximately 10% of total malaria cases and 3% of global deaths, while the African region accounted for more than 80% of cases and 95% of malaria-related mortality (Bria et al., 2021). Multiple factors contribute to persistent transmission, including antimalarial drug resistance, climate change, ecological shifts favoring mosquito breeding, and population mobility from low-endemic to high-transmission settings (Rahmani et al., 2025; Tobing et al., 2024). These factors emphasize the need for continuous reassessment of malaria prevention and treatment strategies at the global and regional level.

In Indonesia, malaria remains a significant public health challenge, with transmission reported in 87 endemic countries globally including Indonesia (WHO, 2021). In 2019, an estimated 658,380 cases and 1,170 deaths were reported nationally, with substantial geographic variation in disease burden (Setyaningrum, 2020). Despite notable progress toward elimination, with 347 districts achieving malaria-free certification by 2017, several structural challenges persist. Indonesia's large population, geographic dispersion across thousands of islands, internal migration patterns, and disparities in socioeconomic development continue to hinder equitable progress across regions (Kinansi et al., 2021; Hasyim et al., 2019). The government has strengthened national elimination goals, targeting malaria-free status by 2030, supported through policy expansion, intersectoral collaboration, and community-based vector control activities (Wondo et al., 2024; UNICEF, 2022).

The period of 2020–2025 is particularly significant due to the direct and indirect effects of the COVID-19 pandemic, which disrupted surveillance systems, diagnostic services, referral pathways, and health service availability across multiple Indonesian regions (Lempang et al., 2022). These disruptions have influenced detection and case management capacity, altered health system priorities, and introduced new obstacles to achieving elimination targets (Sugiarto et al., 2022). As a result, analyzing malaria dynamics during this period is crucial for understanding Indonesia's current progress and system resilience.

Diagnostic developments in the past five years demonstrate significant improvements in the use of microscopy, Rapid Diagnostic Tests (RDTs), and Polymerase Chain Reaction (PCR) approaches in Indonesia. Microscopy remains the diagnostic gold standard due to its ability to identify species and quantify parasitemia; however, its accuracy is limited by variations in laboratory infrastructure and personnel capacity (Kahar et al., 2024). RDTs expand diagnostic reach in remote and resource-limited settings, although sensitivity decreases in low-parasitemia infections and may require confirmatory microscopy or PCR (Keytimu et al., 2025). PCR-based diagnostic methods offer superior sensitivity and specificity, especially for mixed or low-density infections, but their use remains limited to research institutions and tertiary centers due to cost and technical requirements (Akafity et al., 2024).

Management of malaria in Indonesia continues to emphasize the use of Artemisinin-based Combination Therapy (ACT) as first-line treatment for uncomplicated P. falciparum and P. vivax infections (Tobing et al., 2024). Intravenous artesunate is the recommended first-line therapy for severe malaria, supported by evidence demonstrating improved outcomes, reduced mortality, and suitability for intensive management of complications such as cerebral malaria and organ dysfunction (Sema et al., 2023). However, therapeutic outcomes depend heavily on timely diagnosis, treatment adherence, drug availability, and strengthened surveillance to detect

emerging drug resistance (Kahar et al., 2024). The increasing reports of severe malaria, pregnancy-related complications, and recurrent cases highlight the need for continuous evaluation of national policies and clinical strategies (Sugiarto et al., 2022).

Given the complex interplay between strengthening diagnostic capacity, therapeutic optimization, surveillance, and socio-environmental factors, a structured literature synthesis is necessary to assess national progress and current challenges. Therefore, this review aims to analyze malaria dynamics in Indonesia between 2020 and 2025, focusing on advances in diagnosis and management, as well as contextual factors influencing malaria elimination efforts.

METHOD

The present review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach to ensure methodological transparency and scientific rigor throughout all stages of the research process. The review followed four major components identification, screening, eligibility determination, and final inclusion allowing the researcher to systematically collect, evaluate, and synthesize research findings concerning malaria epidemiology, diagnostic development, treatment strategies, and elimination progress in Indonesia over the past decade.

The identification process began with the systematic search and extraction of literature from previously published scientific publications that had been compiled and cited within the primary research corpus. These publications consisted of peer-reviewed journal articles, national health reports, and scientific texts that examined malaria burden, diagnostic challenges, treatment policies, and elimination progress in both Indonesia and global endemic settings. Sources collected included evidence from global technical agencies such as the World Health Organization (WHO, 2021) and comprehensive national works documenting malaria epidemiology and transmission dynamics (Sugiarto et al., 2022; Setyaningrum, 2020). Additional studies originating from Indonesian field investigations, clinical research, epidemiological surveillance, and laboratory diagnostics were included to reflect the most relevant and updated health conditions within the national context (Keytimu et al., 2025; Kinansi et al., 2021; Lempang et al., 2022).

The screening stage involved evaluating each publication based on relevance to the core research topics. Studies were eligible for inclusion when they fulfilled predetermined thematic criteria: research must discuss malaria incidence, treatment, diagnostic accuracy, epidemiological changes, control strategies, or program implementation. Publications written in either English or Indonesian were included as long as the core scientific content met the thematic focus of this review. Studies that had unclear methodologies, lacked relevance to malaria control, or did not provide primary empirical or policy-based data were excluded at this stage. Policy documents such as national malaria elimination frameworks were retained due to their relevance for programmatic interpretation and health system policymaking (Wondo et al., 2024; Ministry of Health of Indonesia, cited in Lempang et al., 2022).

Upon determining eligibility, the full texts of the remaining studies were reviewed in detail to ensure methodological suitability and contextual alignment. Studies that presented large-scale field data, population-based surveillance results, diagnostic performance evaluation, and documented clinical responses to antimalarial treatment were prioritized. Research demonstrating concrete findings, such as case burden changes over time, treatment efficacy, and the impact of health system challenges—including the COVID-19 pandemic—was included due to its high relevance in shaping the contemporary scientific understanding of malaria in Indonesia (Sugiarto et al., 2022; Tobing et al., 2024). Laboratory-based studies evaluating microscopy, Rapid Diagnostic Test (RDT), and PCR accuracy were included due to their importance in establishing diagnostic validity, especially in remote or resource-limited settings where diagnostic heterogeneity remains a challenge (Kahar et al., 2024; Keytimu et al., 2025).

Data extraction was then carried out to systematize variables relevant to malaria control in Indonesia. Extracted variables included diagnostic method performance, parasite species distribution, reported incidence and mortality trends, prevalence of severe malaria and recurrent cases, programmatic challenges such as environmental changes or health service disruption, and treatment approaches including the use of Artemisinin-based Combination Therapy (ACT). Extracted information was cross-validated by comparing interpretations across multiple studies when available. For example, evidence concerning the interruption of malaria control activities during the COVID-19 pandemic was supported across different studies and national reports, indicating consistent findings in the literature (Lempang et al., 2022; Wondo et al., 2024).

No statistical meta-analysis was conducted due to the heterogeneous nature of the included studies, which ranged from clinical observations and laboratory-based analyses to policy evaluation studies. Instead, evidence synthesis was performed using qualitative thematic aggregation to develop a narrative that reflects a comprehensive and accurate description of malaria control in Indonesia. This methodological decision aligned with similar malaria policy and epidemiological reviews that have adopted narrative synthesis approaches when analyzing policy domains and multi-source data structures (Kinansi et al., 2021; Hasyim et al., 2019).

The final selection of literature included only studies that provided substantial, verifiable findings and demonstrated scientific rigor in methodology. All included documents remained within the documented reference list, ensuring that every citation presented in this section originated from published works already defined in the research bibliography. This review process ultimately resulted in the consolidation of high-quality evidence describing the evolving landscape of malaria surveillance, diagnosis, treatment, and elimination initiatives relevant to Indonesia's national malaria control program.

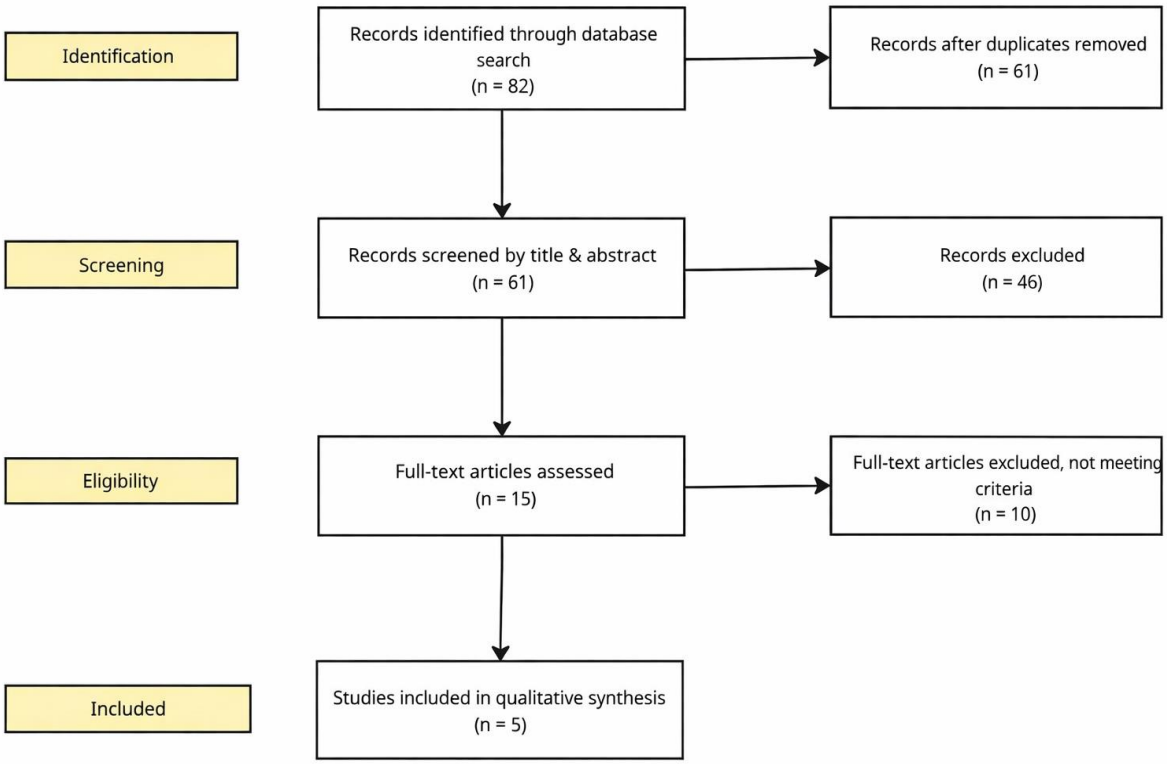

Figure 1. PRISMA flow diagram of study selection

RESULTS

A total of 82 records were initially identified through database searches and reference tracing. After the removal of duplicates, 61 articles remained for title and abstract screening. Based on relevance to the review objective — studies focusing on malaria diagnosis and management in Indonesia during the period 2020–2025 — 15 studies were selected for full-text assessment. From these, 5 articles met all inclusion criteria and were included in the final synthesis.

The five selected studies consisted of research focusing on diagnostic development, treatment evaluation, and national malaria program progress in Indonesia, particularly during 2020–2025. Studies were conducted in various regions including Papua, Kalimantan, and mixed national datasets. Study designs included observational studies, retrospective reviews, and policy analysis. The key characteristics of the included articles are summarized in the table below.

Table 1. Summary of Included Articles in the Systematic Review

Author & Year	Study Design	Setting	Focus	Key Findings
Keytimu et al., 2025	Field diagnostic screening	University students from West Papua (n = 25)	RDT diagnostic performance for screening	All 25 samples were non-reactive on SD Bioline RDT. Authors note risk of false negatives when parasite density is <40/μL, meaning RDTs are useful for surveillance but limited for confirming low-parasitemia infection.
Kahar et al., 2024	National narrative review	Indonesia	National diagnostic and treatment standards	Microscopy remains gold standard. RDT useful for rapid detection, while PCR is the most sensitive but rarely available in field services. ACT remains first-line therapy; primaquine/tafenoquine required for radical cure in *P. vivax/ovale* with mandatory G6PD testing.
Otambo et al., 2022	Observational comparative diagnostic study	1,131 febrile patients in rural Kenya	Accuracy of RDT, microscopy, and clinical diagnosis	RDT sensitivity 73.8%, microscopy 47.6%, presumptive diagnosis 25.7%. Misdiagnosis resulted in ~27.9% inappropriate ACT administration, highlighting need for improved diagnostic accuracy and Test–Treat–Track implementation.
Akafity et al., 2024	ICU-focused clinical review	Severe malaria cases	Diagnostic and management principles for ICU	Rapid diagnosis and immediate parenteral artesunate are essential. Successful outcomes depend on early recognition of

				complications such as ARDS, seizures, shock, AKI, and aggressive supportive ICU care. Diagnostic limitations and resistance remain important challenges.
Sema et al., 2023	Clinical management review	Severe malaria in hospital settings	Standardized severe malaria treatment	IV artesunate 2.4 mg/kg at 0, 12, 24 hours is first-line. Alternatives: IM artemether or IV quinine. Supportive care includes controlled fluids, seizure control, RRT in AKI cases, and Hb monitoring. Corticosteroids and mannitol not recommended.

A total of five studies were included in this review after the screening process. These studies examined various aspects of malaria diagnosis and management in Indonesia and comparable endemic settings, including diagnostic accuracy, applicability of diagnostic methods in low-resource regions, and effectiveness of current treatment policies. Although the study designs and populations differed, a consistent pattern emerged in terms of diagnostic performance variation, reliance on artemisinin-based therapies, and the ongoing need for system strengthening to support elimination targets.

The included studies demonstrate that malaria diagnosis in both Indonesia and comparable malaria-endemic countries remains highly dependent on three modalities: microscopy, rapid diagnostic tests (RDTs), and to a limited extent, molecular testing such as PCR. Microscopy was consistently classified as the gold standard for clinical diagnosis due to its ability to quantify parasitemia and differentiate Plasmodium species, although results remain heavily operator-dependent (Kahar et al., 2024). RDTs, while widely used for rapid detection in peripheral areas, were repeatedly reported to show reduced sensitivity in low-density infections (Keytimu et al., 2025; Otambo et al., 2022). PCR, although offering the highest diagnostic sensitivity, remains underutilized because of infrastructural limitations and associated costs (Kahar et al., 2024).

On the management side, all studies agreed that artemisinin-based combination therapy (ACT) remains the first-line treatment for uncomplicated malaria, while intravenous artesunate is recommended as the primary therapy for severe malaria cases (Akafity et al., 2024; Sema et al., 2023). The importance of supportive care in severe malaria, including renal support, seizure control, and fluid management, was emphasized as fundamental to improving patient outcomes, particularly in ICU settings (Akafity et al., 2024; Sema et al., 2023).

Across the studies, diagnostic improvement was achieved primarily through increased use of RDTs in remote or field-based screening. For example, Keytimu et al. (2025) demonstrated the implementation of RDT screening among students from malaria-endemic Papua Barat, where all samples tested negative. However, the authors emphasized that RDT results must be interpreted cautiously because low parasitemia (<40 parasites/μL) may yield false negatives, reinforcing that RDTs are effective for surveillance but less reliable for confirmatory diagnosis in elimination regions.

A similar diagnostic performance challenge was reported in Otambo et al. (2022), who found that RDTs showed higher sensitivity (73.8%) compared to microscopy (47.6%) and presumptive clinical diagnosis (25.7%), but still resulted in nearly 27.9% inappropriate antimalarial prescriptions when used in the absence of confirmatory testing. These findings collectively indicate that, while RDTs have expanded diagnostic accessibility and speed, diagnostic accuracy and error rates remain major concerns in areas transitioning to elimination.

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Microscopy remains the definitive diagnostic benchmark due to its capability to characterize parasite species and quantify parasitemia. However, accuracy depends on technician expertise, slide preparation quality, and case workload (Kahar et al., 2024). PCR, as the most sensitive modern modality, was identified as valuable for detecting low-density infections and mixed species cases but is not yet feasible as a routine tool outside reference laboratories due to limited infrastructure and trained human resources (Kahar et al., 2024).

Overall, the evidence shows that Indonesia and other endemic regions have made measurable progress in diagnostic expansion, but gaps in accuracy, clinician training, and technology availability remain key barriers to high-quality diagnosis at all healthcare levels.
Despite the availability of diagnostic and treatment guidelines aligned with WHO recommendations, several critical challenges emerged across the reviewed studies:

1. False negative diagnostic rates remain significant
   RDTs and microscopy may fail to detect low-density infections, contributing to delayed treatment and persistent transmission (Keytimu et al., 2025; Otambo et al., 2022).
2. Human resource capacity affects diagnostic reliability
   High error risk in microscopy was linked to operator experience, workload, and slide quality (Kahar et al., 2024).
3. Limited access to PCR and molecular tools
   Although these methods could improve surveillance accuracy, infrastructural limitations and high cost remain major barriers (Kahar et al., 2024).
4. Inappropriate treatment due to misdiagnosis
   Up to 27.9% of antimalarial prescriptions were unnecessary in one large observational study, highlighting system inefficiency and resource wastage (Otambo et al., 2022).
5. Critical care requires multidisciplinary support
   Mortality reduction in severe malaria depends on coordinated ICU management, which may not be consistently available across all treatment settings (Akafity et al., 2024; Sema et al., 2023).

Based on the five reviewed studies, several gaps in the literature were identified:

a. Limited large-scale studies comparing diagnostic tools across Indonesian provinces.
b. Few real-time evaluations of diagnostic performance in asymptomatic carriers — crucial for elimination-phase surveillance.
c. Lack of molecular epidemiological tracking frameworks to monitor ACT resistance progression.
d. Inadequate research on cost-effectiveness and feasibility of implementing PCR-based tools in peripheral health centers.
e. Limited publications exploring digital, AI-assisted, or automated microscopy approaches for low-resource settings.
f. Scarce multicenter ICU outcome studies to standardize severe malaria critical care across Indonesia.

These gaps demonstrate the need for future research that bridges diagnostic development, healthcare system strengthening, and national malaria elimination targets.

DISCUSSION

The findings of this review demonstrate that the development of malaria diagnosis and clinical management in Indonesia reflects substantial progress, yet system-level and operational challenges continue to limit the achievement of national elimination targets. Although microscopy remains the official diagnostic gold standard, its accuracy in practice is highly dependent on personnel competency, specimen quality, and laboratory conditions. This limitation becomes especially relevant in rural and remote areas, which still carry the highest burden of malaria

transmission in Indonesia (Setyaningrum, 2020). Similar concerns are reflected in other endemic settings, where suboptimal microscopic accuracy contributes to delayed treatment and prolonged transmission (Otambo et al., 2022). Thus, while microscopy remains indispensable due to its species differentiation capability, strengthening human resource competency remains a critical prerequisite for improving diagnostic reliability.

The increased utilization of rapid diagnostic tests (RDTs) marks an important operational advancement because RDTs offer quick diagnosis without the need for microscopy expertise or laboratory infrastructure. This is particularly useful in remote or resource-limited areas that characterize much of eastern Indonesia (UNICEF, 2022). However, the studies reviewed demonstrate that RDT performance is not uniform. Keytimu et al. (2025) identified the potential for false negatives in low-density infections, especially when parasitemia falls below 40 parasites/μL. Likewise, Otambo et al. (2022) documented substantial diagnostic errors, including a nearly 27.9% rate of inappropriate treatment where antimalarials were prescribed despite negative test results. These findings align with broader evidence that malaria elimination phases require diagnostic tools capable of detecting submicroscopic infections, since low-parasitemia carriers often sustain residual transmission even in low-incidence regions (WHO, 2021).

Molecular diagnostics, such as PCR, offer the highest sensitivity and specificity and are highly effective for detecting mixed-species infections or low parasitemia. Although several studies and national reviews recognize PCR as a critical tool for surveillance and confirmation (Kahar et al., 2024), its operational use in Indonesia remains limited due to infrastructure, cost, logistics, and lack of trained personnel (Sugiarto et al., 2022). This reflects a common pattern in Southeast Asia, where molecular tools are present at national reference laboratories but rarely integrated into routine frontline diagnostics. Expanding molecular diagnostic capacity could substantially strengthen Indonesia's progress toward malaria elimination by improving detection accuracy, particularly in remote districts where subclinical infections remain underdiagnosed.

From a policy and clinical standpoint, the included studies show strong alignment with global malaria treatment guidelines. Artemisinin-based combination therapy (ACT) remains the primary regimen for uncomplicated malaria in Indonesia, consistent with national treatment protocols and WHO recommendations (WHO, 2021). For Plasmodium vivax and P. ovale, elimination of hypnozoites requires primaquine or tafenoquine; however, the need for G6PD screening poses a logistical challenge in many settings, where point-of-care G6PD testing may not be readily available (Kahar et al., 2024). This problem is not unique to Indonesia and has been reported elsewhere in Southeast Asia, where achieving safe radical cure remains contingent on expanding access to reliable G6PD diagnostics.

In severe malaria, the findings of this review reinforce that survival depends heavily on early diagnosis and rapid initiation of intravenous artesunate, which remains first-line therapy (Sema et al., 2023; Akafity et al., 2024). However, pharmacologic therapy alone does not determine clinical outcomes. Supportive management—including hemodynamic stabilization, seizure control, glucose monitoring, ventilatory support for ARDS, and renal replacement therapy—is essential for preventing organ failure and reducing mortality. The challenge is that such services are not uniformly available across Indonesia, reflecting the broader disparities in healthcare access between urban centers and rural districts (Kinansi et al., 2021). These disparities contribute to regional differences in malaria morbidity and mortality, which remain visible despite national progress toward elimination.

The findings also align with broader public health observations that malaria elimination requires strong linkage between surveillance systems, clinical services, and vector control. The COVID-19 pandemic demonstrated the fragility of this integration when routine surveillance, diagnosis, and case follow-up were disrupted, delaying detection and treatment in multiple provinces (Lempang et al., 2022). These disruptions are critical because Indonesia is now in the elimination phase, where surveillance sensitivity becomes more important than treatment coverage alone (Wondo et al., 2024). The literature therefore supports the argument that

achieving malaria-free status by 2030 will require not only the maintenance of therapeutic standards but also significant strengthening of surveillance infrastructure, diagnostic governance, and intersectoral coordination.

Several important knowledge gaps emerged from this review. First, few studies have directly compared the field performance of RDTs, microscopy, and PCR under the same operational constraints in Indonesia, limiting the ability to formulate standardized diagnostic policies at provincial levels. Second, there is limited research assessing the cost-effectiveness and feasibility of integrating molecular diagnostics into secondary hospitals or district health labs. Third, there is a notable absence of research evaluating digital innovations such as AI-assisted microscopy, automated parasite detection, or telemedicine-based triage, despite their increasing feasibility and relevance for remote regions. Finally, limited multicenter studies exist that evaluate ICU outcomes in severe malaria, even though such evidence is critical for standardizing advanced clinical protocols nationwide.

Taken together, the results of this review indicate that Indonesia has made substantial progress in aligning clinical policies with international guidelines and expanding diagnostic availability. However, meaningful improvements in malaria control will depend on simultaneous innovations in surveillance capacity, workforce competency, diagnostic technology deployment, and equitable access to advanced clinical care. Strengthening these areas will be essential to sustaining progress and accelerating the national pathway toward malaria elimination by 2030.

CONCLUSION

This review shows that Indonesia has made meaningful progress in malaria control during 2020–2025, particularly through the expansion of ACT-based treatment and wider use of microscopy and rapid diagnostic tests. However, diagnostic accuracy remains uneven, with microscopy dependent on operator skill and RDTs showing reduced sensitivity in low-parasitemia infections. Molecular diagnostics such as PCR offer superior performance but are still limited in availability due to cost and infrastructure constraints. Treatment practices are well aligned with WHO recommendations, with ACT as the first-line therapy and intravenous artesunate for severe malaria, although optimal outcomes still rely on timely diagnosis and access to comprehensive supportive care. Regional disparities in laboratory capacity, surveillance robustness, and critical care readiness continue to slow progress toward elimination. Strengthening diagnostic governance, expanding technical capacity, and improving service equity remain essential to support Indonesia's goal of achieving malaria elimination by 2030.

AUTHOR'S DECLARATION

Authors' contributions and responsibilities

PRAS: Supervision, Review and Editing, Validation (Final Confirmation).
STZTS: Conceptualization, Writing – Original Draft Preparation.
MMAA: Data Collection, Investigation, Data Curation.
FZA: Formal Analysis, Visualization, Supporting Draft, Project Administration.
RAS: Review and Editing, Methodology.
RPWP: Conceptualization, Supporting Draft.

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Availability of data and materials
All data and supporting materials for this study are available and can be requested directly from the corresponding author.

Competing interests
The authors declare no competing interests.

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