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Sensitivity Concordance Between Rapid Diagnostic Tests and Thick Smears for Detecting Malaria at Sultan Cherif Kasser Hospital, N'Djamena Central Health District

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Abstract: Malaria is a parasitic infection transmitted to humans by insect bites. It remains the deadliest parasitic disease and is a major public health problem. The objective of this study was to evaluate the sensitivity of a rapid diagnostic test (RDT) compared to thick smear microscopy, considered the gold standard. Blood samples from 427 patients aged 1 to 86 years were examined using both RDTs and thick smears in the laboratory. Of the 427 participants, 382 had identical results, representing an overall concordance of 89.5%, including 182 (42.6%) true negatives (TS- RDT-) and 200 (46.8%) true positives (46.8%) (RDT+ and TS+). In 45 cases of overall discordance, the percentage was 10.5%, divided into 19 cases (4.4%) of false negatives (RDT- and TS+) and 26 (6.1%) of false positives (RDT+ and TS-). The most represented age group was 18–50 years, followed by 1–5 years. The sensitivity of the rapid diagnostic test (RDT) was 91.3%. The specificity of the RDT was 87.5%. The positive predictive value (PPV), representing the probability that a patient who tests positive is actually infected with malaria, was 88.5%, and the negative predictive value (NPV), indicating the probability that a patient who tests negative is actually uninfected, was 90.5%. RDTs and thick smears are diagnostic tools for malaria in Plasmodium patients and for assessing parasitemia in order to provide effective antimalarial treatment to patients. They are the main means of combating malaria. However, thick smears remain essential, particularly for quantifying parasitemia and identifying clinically suspected cases that may be negative on RDT.

Keywords*: Malaria, Rapid Diagnostic Test, Thick Smear, Sensitivity, Specificity, Health District, N'Djamena, Chad.*

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I. INTRODUCTION

Malaria is an acute febrile parasitic disease caused by parasites of the genus Plasmodium, transmitted to humans by the bite of female mosquitoes of the genus Anopheles [1]. Developing in the liver cells of infected humans, the parasite circulates in the bloodstream while invading and destroying red blood cells [2]. Five species of Plasmodium are responsible for infection in humans: P. falciparum, P. ovale, P. vivax, P. malaria, and P. knowlesi [3]. Malaria remains a major public health problem. According to the latest WHO report on malaria worldwide, the number of malaria cases was estimated at 263 million with 59,700 deaths, approximately 11 million more cases than in 2022 and almost the same number of deaths. Approximately 95% of deaths occurred in the WHO African region [4].

In Chad, malaria remains a public health problem because the burden of the disease is still heavy, particularly in certain regions of the country. Children under five and

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pregnant women are the most affected. In 2023, the country recorded 1,727,230 cases, representing approximately 30% of all new consultations received by health facilities, and caused the deaths of 2,864 people during the same year, representing approximately 28% of all deaths recorded by the country [5].

According to WHO recommendations in its malaria management policy, each suspected case of malaria must be confirmed by a biological test, either a Rapid Diagnostic Test or Microscopy. This confirmation allows for the optimal use of antimalarial drugs, thereby reducing therapeutic errors that consist of considering all cases of fever as malaria, when other less common parasitic and/or infectious diseases are also responsible for fever [6]. Microscopic examination of a thick smear remains the gold standard in terms of sensitivity and specificity [7]. However, microscopy requires qualified and experienced personnel [8 ; 9]. To overcome these constraints, rapid diagnostic tests (RDTs) have been developed: these are immunochromatographic tests that generally detect specific antigens of the Plasmodium parasite, such as the HRP2 (Histidine-Rich Protein 2) protein produced by Plasmodium falciparum [10]. Their ease of use, speed (results in less than 20 minutes), and independence from laboratory equipment make them particularly useful in rural or remote areas [10]. In recent years, their use has increased significantly worldwide. Manufacturers surveyed by the WHO [3] reported selling 3.1 billion RDTs during the period 2010-2020, 81% of which were in the WHO African Region. During the same period, 2.2 billion were distributed by national malaria control programs, 81% of which were in sub-Saharan Africa [5].

However, few studies have looked at the performance of rapid diagnostic tests (RDTs) despite their widespread use. Due to the lack of local data on the comparative performance of RDTs and thick smears, it is crucial to conduct local evaluations to verify their effectiveness.

II. MATERIALS AND METHODS

➢ *Study Site*

This study was conducted in the Ndjamena Central Health District from July 25 to September 15, 2025, located in the capital of the Republic of Chad. This district includes several public health facilities, among which is the Sultan Chérif Kasser Hospital, which was the research site (figure). The Sultan Chérif Kasser Hospital in N'Djamena is one of five hospitals in the municipality of Ndjamena and is the hospital for the Ndjamena Central Health District. Located in the Gardolé neighborhood in the third district of the municipality of N'Djamena, it is bordered to the north by the central market, to the south by the Lycée de la Concorde, to the east by Social Center No. 1, and to the west by the La Référence Nationale University Hospital. The population served by this hospital is estimated at 433,624 inhabitants (source: hospital). It offers several services. The choice of this site was motivated by:

- The high number of patients visiting the hospital;
- The availability of diagnostic equipment, particularly for thick smear and rapid diagnostic tests.
- The accessibility and collaboration of the medical staff.

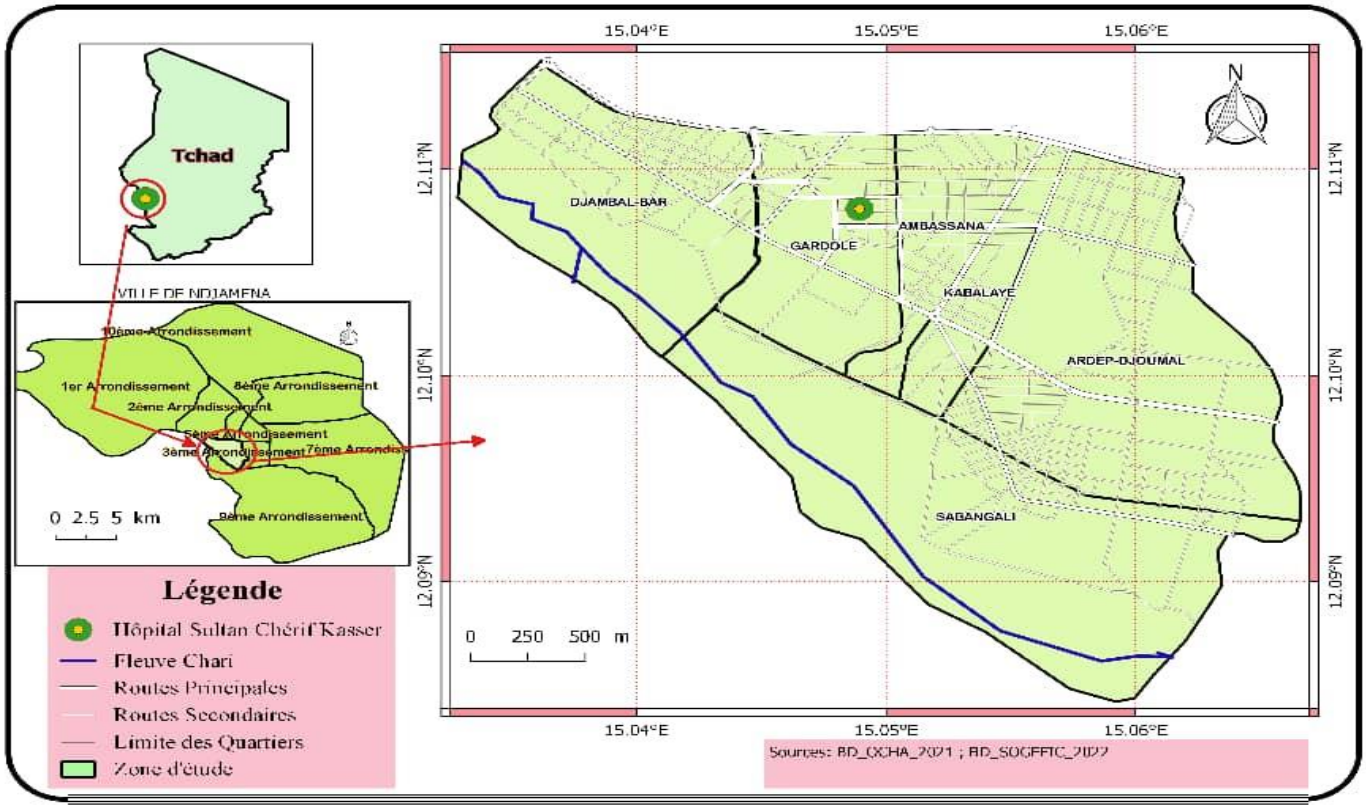

Fig 1: Study Site Map

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III. METHODOLOGY

A. *Type of Study*

This was a cross-sectional study.

B. *Study Period*

It took place from July to September 2025, i.e., over a period of three months.

C. *Study Population*

The study population consisted of volunteer patients of all ages who were seen in consultation for malaria symptoms and whose medical records indicated that a thick smear or rapid diagnostic test (RDT) was to be performed.

➢ *Inclusion criteria*

- All patients coming to the district with symptoms of malaria (fever, chills, etc.);
- Informed consent from each patient.

➢ *Exclusion criteria*

- All patients who have received antimalarial treatment in the two weeks prior to the study;
- Patients who do not consent will not be included in the study;
- Other infections that may interfere with the diagnosis.

➢ *Blood Sampling*

After verifying the patient's identity, i.e., first and last name, age, and location, the tube was numbered with the patient's initials (first and last name), the patient was positioned, and the examiner put on gloves and attached the safety needle to the pump. The patient was seated, extended their arm, and flexed their wrist. The tourniquet was tied just above the elbow, fairly tightly. A large-caliber vein was selected and the puncture site was disinfected with alcohol-soaked cotton. The needle cap was removed. The bevel was gently inserted in the direction of the vein until it was completely inserted at an angle. At the moment of puncture, the needle body formed a 150° angle with the patient's arm. The EDTA tube was inserted and allowed to fill to the desired volume. While holding the needle, the tourniquet was tightened with one hand and the patient was asked to relax their wrist. The needle was removed and the puncture site was compressed to prevent bruising. Immediately after the sample was taken, the needle was placed in the sharp's container. Gloves were removed and discarded. Apply a bandage. After the collection, the labels and the patient's identity were checked for consistency.

➢ *Preparation of Thick Smear (TS)*

Interpretation of results: a positive thick smear was observed in the form of one of the following: trophozoites, schizonts, merozoites, or gametocytes. The number of leukocytes and the number of parasites can be counted, which led us to calculate the parasite density using the following formula:

PD = number of parasites counted/number of leukocytes counted x number of leukocytes per microliter of blood (8,000 leukocytes per microliter)

➢ *Performing the Rapid Diagnostic Test (RDT)*

This is an immunological method that allows for the rapid detection of specific antigens of the malaria parasite in the blood. The rapid diagnostic test (RDT) was performed at room temperature and on the spot. The expiration date was checked. The RDT was placed on a clean, flat horizontal surface. Once the pouch was opened, we numbered it with the patient's number and the date of the test. We mixed the blood by inverting the tube and, using the sampling loop, we collected 5 microliters of whole blood, which was poured into the well. Next, three drops of buffer solution were added to the sample. The reaction was read and the results were interpreted within 15 to 20 minutes of completion, according to the manufacturer's instructions.

- The test was positive if one line appeared in the control window and one or two lines appeared in the test windows.
- The test was negative if only one line appeared in the control window and no lines appeared in either of the test windows.
- The test was invalid if there was no line in the control window but there was a line in the test window or no lines appeared.

➢ *Determination of Statistical Variables*

- *Positivity rate (PR):* Proportion of diseases (D) in a population (P) at a given time.
- PR (%) = M*100/N Where M is equal to the total number of confirmed positive cases and N is equal to the total number of cases tested (study population).
- *Sensitivity (Se):* Ability of the RDT to detect subjects with malaria
- (GE) in the study population. It thus measures the test's ability to eliminate false negatives (FN).
- Se (%) = VP*100/VP+FN
- *Specificity (Sp):* Ability of the RDT to detect subjects free of malaria (GE) in the study population. It also measures the test's ability to determine false positives (FP)
- *Sp (%)* = TP*100/FP+TP
- *Positive Predictive Value (PPV*): Probability that a patient actually has malaria (GE) when their RDT test is positive.
- PPV (%) = PP*100/PP+FP
- *Negative Predictive Value (NPV):* Probability that a patient is truly free of malaria when their RDT is negative.
- NPV (%) = NP*100/NP+FN

Table 1: Predefined Contingency Table Used to Compare RDT Results with Those of the Thick Drop Test

RDT+	**VP**	**FP**	**VP+FP**
RDT-	**FN**	**VN**	**VN+FN**
TOTAL	**VP+FN**	**FP+VN**	**FP +VN +FN**
	Sick (TS+)	**Healthy (TS-)**	**Total**

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Where: TP = true positives TN = true negatives
FN = false negatives FP = false positives

➢ *Data Analysis*

The collected data were entered into Excel and analyzed using SPSS and Excel software. The results of the rapid diagnostic test (RDT) were compared to those of the thick smear (TS) (reference test) using the chi-square test, with a significance threshold of 5%. Diagnostic performance indicators, including sensitivity, specificity, positive predictive value, and negative predictive value, were calculated in relation to microscopy (thick smear).

➢ *Ethical Considerations*

This work was carried out after obtaining:

- A certificate of internship provided by the University of N'Djamena;
- A research authorization provided by the chief physician of Sultan Chérif Kasser Hospital;
- And verbal consent from each participant, or verbal consent from parents or guardians for minors.

IV. RESULTS

This study involved 427 patients. In total, we performed 427 thick smears and 427 rapid diagnostic tests.

➢ *Sociodemographic Characteristics*

Table 2: Distribution of Study Subjects by Gender.

Gender	Number	Percentage (%)
Male	181	42.4
Feminine	246	57.6
Total	**427**	**100**

This study involved 42.4% male subjects and 57.6% female subjects, with a sex ratio of 0.74, meaning that for every 100 women, there were 74 men. The study population was therefore predominantly female.

Table 3: Distribution of Participants by Age Group Female

Age Groups		NE	%	Ẋ	Min	Max
	1-5	68	15.9	25.85	1	85
	6-11	28	6.6			
	12-17	31	7.3			
	18-50	265	62.1			
	51 et +	35	8.2			
Total		**427**	**100**			

NE= number examined X=average age; Min = minimum age; max= maximum age.

Participants ranged in age from 1 to 85. The average age was 25. The 18-50 age group was the most represented, followed by the 1-5 age group.

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➢ *Malaria Prevalence Determined by TS and RDT According to Gender*

Table 4: Malaria Prevalence Determined by TS According to Gender

Gender		TS- **(%)**	TS+ **(%)**
	Male	97 (53,9)	83 (46,1)
	Feminine	110 (45,1)	134 (54,9)
χ^2	3,2079		
p-value	0,0733		

Thick Smear = TS

The prevalence of malaria determined by thick smear was higher in females (54.9%) than in males (46.1%). Although this difference was numerically significant, no statistically significant association between gender and malaria prevalence determined by thick smear (TS) was found (p=0.174>0.05).

➢ *TS and RDT Results by Age Group.*

Table 5: TS Results by Age Group

Age group		**TS- (%)**	**TS+ (%)**	χ^2	**p-value**
	1-5	27(39,7)	41(60,3)	5,927	0,205
	6-11	10(35,7)	18(64,3)		
	12-17	17(54,8)	14(45,2)		
	18-50	134(50,6)	131(49,4)		
	51 et +	20(57,1)	15(42,9)		
Total		**208(48,7)**	**219(51,3)**	**427(100)**	

Thick Smear = TS

The prevalence of malaria determined by thick smear in the study population was highest among children aged 6–11 years (64.3%), followed by those aged 1–5 years (60.3%).

➢ *Comparison of RDT Results at TS*

Table 6: Comparison of RDT Results at TS

RDT	**TS- (%)**	**TS+ (%)**	**Total**	χ^2	**P-value**
RDT-	182 (42,6)	19 (4,4)	201(47,1)	266	<0,0001
RDT+	26 (6,1)	200 (46,8)	226 (52,9)		
Total	**208(48,7%)**	**219(51,3%)**	**427 00)**		

Thick Smear = TS

Table 6 compares the results obtained with the two diagnostic techniques in the study population. Of the 427 participants, 382 had identical results, representing an overall concordance rate of 89.5%, including 182 (42.6%) true negatives (TS- RDT-) and 200 (46.8%) true positives (46.8%) (RDT+ and TS+). In addition, in 45 cases we observed a discrepancy, representing an overall discrepancy rate of 10.5%, divided into 19 cases (4.4%) of false negatives (RDT- and TS+) and 26 (6.1%) of false positives (RDT+ and TS-).

The chi-square test showed a highly significant association between the RDT result and the thick film result. (Chi-square: 266. P-value: <0.0001).

➢ *Determination of RDT Performance Parameters Relative to TS.*

The performance parameters were calculated using their respective formulas mentioned above, and the values are recorded in the table opposite.

Table 7 : RDT Performance Parameters

Performance Parameters	**Values %**	**IC95 %**
Sensitiviity	91, 3	86 ,8-94,4
Specificity	87,5	82, 3-91, 3
VPP	88 ,5	83 ,7-92,2
VPN	90 ,5	85,7-93 ,9

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The sensitivity of the rapid diagnostic test (RDT), i.e., its ability to correctly detect cases of malaria, was 91.3% (95% CI: 86.8–94.4). The specificity, corresponding to the RDT's ability to correctly identify healthy subjects, was 87.5% (95% CI: 82.3–91.3). The positive predictive value (PPV), representing the probability that a patient who tests positive actually has malaria, was 88.5% (95% CI: 83.7–92), while the negative predictive value (NPV), indicating the probability that a patient who tests negative is actually free of the disease, was 90.5% (95% CI: 85.7–93.9).

V. DISCUSSION

This study included 427 participants aged 1 to 86. In the overall study population, females were more represented (57.6%) than males (42.4%), giving a sex ratio of 0.74, or approximately 74 males for every 100 females. This result is comparable to that reported by Traoré. S found a ratio of 0.80 in favor of women in an evaluation study of RDT in Mali [11], but contrary to that of Konan. B found a ratio of 1.05 in favor of men in an evaluation study of the First Response Malaria Ag. pLDH/HRP2 COMBO test in Abidjan (Ivory Coast) [12]. This overrepresentation of women in our study could be explained by the fact that certain services, such as gynecology and maternity, exclusively treat women, which increases their proportion in the sample.

The most represented age group in our study was 18-50 years, followed by 1-5 years. This result is identical to that reported by Diallo I. in a study evaluating a rapid diagnostic test in Mali [13].

In our study, the prevalence of malaria determined by thick smear was highest among children aged 6 to 11 years, followed by those aged 1 to 5 years. This result is consistent with WHO data indicating that children are particularly vulnerable to malaria [14]. This result can be explained by the fact that children have immature immune systems, making them more susceptible to malaria infections.

The prevalence of malaria determined by the two tests was higher in females (TS: 54.9% vs. 46.1% in males and RDT: 54.5% vs. 50.8% in males). Although this difference was numerically significant, no statistically significant association between gender and malaria prevalence was found ($p > 0.05$). This trend could be explained in part by the overrepresentation of women in our sample.

Distribution by department showed that the prevalence of malaria according to both tests was higher in maternity wards (63.8%) and pediatrics (58.5%). This result is consistent with existing who literature, which indicates that pregnant women and children are most affected by malaria [14]. This result can be explained by the particular vulnerability of these populations: children have immature immune systems, and pregnant women are more susceptible due to immune changes and sequestration of the Plasmodium falciparum parasite by the placenta. Malaria prevalence was high among patients reporting the use of mosquito nets. This result is consistent with that observed by Sarrassat and al. in [15] in Mali. This result can be explained by the fact that the effectiveness of mosquito nets does not depend solely on their use but can be influenced by other factors such as sleeping habits and the quality of the nets.

In this study, fever was the only clinical sign significantly associated with positive RDT and TS results compared to the main symptoms studied. This result is consistent with that reported by Kamaliddin and al [16] in a study conducted in Kenya, where fever showed high sensitivity for malaria detection. These results highlight that, although certain clinical signs may raise suspicion of malaria, they do not in themselves constitute reliable criteria for confirmation, hence the need for parasitological tests.

In our study, the prevalence of malaria was 51% by thick smear versus 53% by RDT. Similar results were reported in Angola (TS: 15.9%; RDT: 16.3%) [17] and Ghana (TS: 40%; RDT: 41%) [18], confirming the slight superiority of RDT. This difference can be explained in particular by the persistence of the HRP2 antigen, but overall, the two methods remain consistent in estimating the parasite burden.

In the entire population studied, we observed an overall concordance of 89.5%, divided into 42.6% true negatives and 46.8% true positives. Furthermore, the overall discordance was 10.5%, divided into 4.4% false negatives and 6.1% false positives. The overall concordance observed in our study is higher than that reported by Magassa [19] (80%) in Mali in a study evaluating an RDT. Similarly, our overall discordance remains lower than that of Magassa (20%). These results suggest that the RDT used in our study has good diagnostic performance [20].

The chi-square test showed a highly significant association between the RDT result and the thick smear result (chi-square = 266, p-value < 0.0001), indicating that the RDT result reliably reflects the presence or absence of malaria. This result is consistent with that of Magassa, who also reported a significant association between the two tests.

The diagnostic performance of the RDT compared to microscopy, which we present below, allows for a better assessment of the reliability of this test in the diagnosis of malaria

The sensitivity observed in our study was 91.3%, which means that out of 100 people actually infected with malaria (TS+), approximately 91 were correctly detected by the RDT. This result is very close to that reported by Teou and al. [21] in Togo, who found a sensitivity of 91.8% for the Advantage P.f. Malaria Card® test and 91.3% for the Advantage Malaria Pan + Pf Card® test. It is also slightly higher than that reported in Mauritania (89%; [22] and significantly higher than that observed in Ethiopia (81%; [23]. This comparison suggests that, despite variations related to the epidemiological context and the type of RDT used, our test (91.3%) has high sensitivity [24].

The specificity observed in our study was 87.5%, meaning that out of 100 people without malaria (ts-), approximately 88 were confirmed negative by RDT. This

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result is close to that reported by Sambe and al. [25] (89%) in Senegal in a study evaluating an RDT, as well as by Ogunfowokan and al. [26] (89%) in Nigeria. This slight difference could be explained by variations in parasite density or field conditions [27].

The negative predictive value (NPV) observed in this study was 90.5%. This result is comparable to that reported in Turkey by Çulha and al. [23], who found 92.9% in a study evaluating the sensitivity of a RDT. This similarity suggests that, in both contexts, RDTs perform well in ruling out malaria in the event of a negative result. The slight difference observed could be explained by the higher prevalence of malaria in our study population, a factor that tends to reduce the NPV. The PPV observed in this study was 88.5%. This result is higher than that reported by Ba et al. in Mauritania, who found 78.1%, but lower than that observed by Teou and al. [21] in Togo (95.7%) in an evaluation study of the TDR Advantage P.f. Malaria Card® for malaria in This comparison suggests that, despite variations related to the contexts and types of tests used, the RDT evaluated in this study retains a reliable ability to identify true positive cases [28].

VI. CONCLUSION

This study evaluated the diagnostic performance of the rapid diagnostic test (RDT) compared to thick smear microscopy, which remains the gold standard for malaria detection. The results obtained reveal high sensitivity (91.3%) and satisfactory specificity (87.5%), reflecting the RDT's ability to detect positive cases while limiting false positives. In addition, the positive predictive value (88.5%) and negative predictive value (90.5%), as well as the overall accuracy of around 90%, confirm the overall reliability of this test in diagnosis. It should be noted that all of these performance parameters fall within their respective confidence intervals, which reinforces the validity and statistical accuracy of the results. These performance parameters corroborate those reported by other authors in Africa and elsewhere, confirming the effectiveness of RDTs as a diagnostic tool, while emphasizing that their effectiveness may vary depending on the epidemiological context, parasite density, and type of test used. These parameters indicate that RDTs are an effective tool and can be used to diagnose malaria, particularly in areas where microscopy is difficult to access due to a lack of qualified human resources or appropriate equipment. However, the persistence of false positives and false negatives reminds us that RDTs cannot completely replace thick smears, but can be used as a complementary tool, particularly in the context of early diagnosis and rapid management of febrile patients. In addition, analysis of the results shows that the initial hypotheses are generally verified.

- *Conflicts of Interest*

The authors declare that they have no conflicts of interest with respect to the data.

REFERENCES

[1]. WHO., (2024). WHO Chad Biennial Report 2022–2023. World Health Organization, Regional Office for Africa. Available at: https://www.afro.who.int [Accessed June 19, 2025].

[2]. Mahittikorn A., Masangkay FR., Kotepui., Milanez GD.et Kotepui M. (2021). Quantification of the misidentification of Plasmodium knowlesi as Plasmodium malariae by microscopy: an analysis of 1569 P. *knowlesi cases. Malaria. J*, 20 : 179.

[3]. Kotepui M., Masangkay FR., Kotepui KU., De Jesus Milanez G. (2020). Misidentification of Plasmodium ovale as Plasmodium vivax malaria by a microscopic method: a meta-analysis of confirmed P. ovale cases. *SCI. Rep*, 10: 21807.

[4]. WHO, (2021). Steps for performing the rapid diagnostic test for Plasmodium falciparum. [Online] Available at: https://www.who.int/fr/teams/global-malaria-programme/case-management/diagnosis/rapid-diagnostic-tests/falciparum-training-videos.

[5]. WHO, (2022). Chemoprevention of seasonal malaria with sulfadoxine-pyrimethamine and amodiaquine for children: field guide (2nd ed.). Geneva: WHO, published November 23, 2022.

[6]. WHO, (2023). Updated vaccination guidance: WHO recommends R21/Matrix-M vaccine for malaria prevention. Press release, October 2, 2023. Geneva: WHO. Available at: https://www.who.int/fr/news/item/02-10-2023-who-recommends-r21-matrix-m-vaccine-for-malaria-prevention-in-updated-advice-on-immunization.

[7]. Dorkenoo A.M., Kouassi K.C., Afanyibo Y.G., Gbada K., Yakpa K., Têko M., Koura A.K., Katawa G., Adams, M. & Merkel, M., (2021). External evaluation of the quality of thick smears/blood smears for the diagnosis of malaria in the health districts of Lomé and Golfe in Togo. *Tropical Medicine and International Health*, 1(1), S1SQ-3476.

[8]. Tembiné I., Sagara I., Sidibé D.M., Konate A., Coulibaly C.A., Zeguime A., Coulibaly M.B., Doucouré M., Sidibé S., Sogodogo B.S., SanogoV., Goïta I.S., Dicko F., and Dolo A., -2023). Performance of microscopists in the diagnosis of malaria at two university community health centers, Mali 2020 to 2021. *Mali Public Health*, 13(2), pp.73-78.

[9]. Ngando L., Kenfack M., Médi Siké C., Ngo Nsintat D., Voundi E., and Same Ekobo A., (2024). Quality assurance of biological diagnostic tools for malaria in laboratories at four healthcare facilities in the city of Yaoundé. *Health Sci. Dis*., 25 (Suppl 3), pp.46-52. Available at: www.hsd-fmsb.org.

[10]. Mercier V., Bailly É., Van Langendonck N., Chevallier E., Bernard L., and Desoubeaux G., (2020). Pitfalls and misuse of rapid diagnostic tests for routine malaria screening. Annales de Biologie Clinique, 78(2), pp.174-176. Available at : https://stm.cairn.info/revue-annales-de-biologie-clinique-2020-2-page-174.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jan1410

[11]. Traoré A., (2021). Epidemiology of severe malaria in children aged 3 months to 15 years in the pediatric ward of Mali Hospital before and after the scaling up of malaria chemoprevention. Doctoral thesis in medicine, University of Science, Technology, and Engineering of Bamako.

[12]. Konan K.B., (2014). Evaluation of the FIRST RESPONSE® Malaria Ag. pLDH/HRP2 combo Test for rapid diagnosis of malaria in Abidjan (Ivory Coast). Doctoral thesis in Pharmacy, Félix Houphouët-Boigny University, Abidjan, Côte d'Ivoire. Available at: https://beep.ird.fr/collect/pha/index/assoc/1778-16/1778-16.pdf.

[13]. Diallo, I. (2024). Evaluation of a rapid malaria diagnostic test compared to thick smear at the MRTC clinical trial site in Donéguébougou during the high malaria transmission season in 2023 (Thesis). USTTB.

[14]. Available at https://fr.scribd.com/document649433037/Paludisme.

[15]. PNLP Chad, (2023). Annual Activity Report 2022. Ministry of Public Health and Prevention, Republic of Chad.

[16]. Sarrassat S., Toure M., Traore M., Diarra A., Coulibaly H., Arou A.Z., Tangara C.O., Muller G., Beier J.C., Vontas J., Bradley J., Traore S.F., Doumbia S. et Kleinschmidt I. (2025). Strategies to reduce residual malaria transmission in areas with high ITN coverage in southwestern Mali. *Malaria Journal*, 24 (1), Article PMC12243244.

[17]. Kamaliddin C., Le Bouar M., Berry, A., Fenneteau O., Gillet P., Godineau N., Candolfi E. & Houzé S. (2020). Assessment of diagnostic methods for imported malaria in mainland France. *Médecine et Maladies Infectieuses*, 50(2), 141–160. DOI: 10.1016/j.medmal.2019.07.007.

[18]. Ba H., Ahouidi A.D., Duffy C.W., Deh Y.B., Diedhiou C., Tandia A., Diallo, M.Y., Assefa, S., Lô B.B., Elkory M.B., and Conway D.J., (2017). Evaluation of the OptiMal-IT® pLDH rapid malaria diagnostic test at the edge of Plasmodium falciparum distribution in Mauritania. *Bulletin de la Société de Pathologie Exotique*, 110 (1), 31–37. https://doi.org/10.1007/s13149-017-0541-y.

[19]. Touré O., (2020). Malaria infection in women giving birth and use of malaria prevention strategies during pregnancy in SAN. Doctoral thesis in medicine and doctorate in medicine. 19. 19. Magassa G., (2022). Study of the sensitivity and specificity of a diagnostic test (SD Bioline Malaria Ag Pf) in a low malaria transmission setting in Sirakorola, Mali. Doctoral thesis in pharmacy, University of Science, Technology, and Engineering of Bamako. [Online] Available at: <https://www.bibliosante.ml/handle/123456789/5374> [Accessed June 9, 2025].

[20]. Zeleke M.T., Gelaye K.A., Hirpa A.A., Teshome, M.B., Guma, G.T., Abate B.T. (2023). Diagnostic performance of PfHRP2/pLDH malaria rapid diagnostic tests in élimination setting, northwest Ethiopia. *PLOS Global Public Health*, 3(7), e0001879. https://doi.org/10.1371/journal.pgph.0001879.

[21]. Teou D.C., Dorkenoo A.M., Ataba E., Alidou S., Yakpa K., Abdou-Kerim A., Maman I., Agbonon A. (2023). Evaluation of the performance of Advantage P.f. Malaria Card® and Advantage Malaria Pan + Pf Card®, two rapid diagnostic tests for parasitological confirmation of malaria cases in Field situation in Togo. *Parasites & Vectors*, 16(1), 444. https://doi.org/10.1186/s13071-023-06062-y.

[22]. Feleke D.G., Alemu Y.A. & Yemanebirhane N., (2021). Performance of rapid diagnostic tests, microscopy, loop-mediated isothermal amplification (LAMP) and PCR for malaria diagnosis in Ethiopia: a systematic review and meta-analysis. *Malaria Journal*, 20(1), p.380. doi :10.1186.

[23]. Çulha G., Önlen Y., Çabalak M., Kaya T. & Küçükeser B. (2024). Investigation of Sensitivity of Rapid Diagnosis Tests in Patients with Suspected Malaria. *Turkiye Parazitol Derg*, 48(1), pp.1–7. DOI: 10.4274/tpd.galenos.2024.3835.

[24]. Houngbedji c.A., N'Guessan R., Djohan V., Diakité s., Traoré K. et Bamba L., (2024). Evaluation of malaria microscopy diagnostic performance at 40 publique Health Facilities in Abidjan, côte d'ivoire in 2020.

[25]. Sambe B.S., Zobrist S, Sheahan W., Soni D., Diagne A., Sarr I., Diatta AS., Diaw SOM., Golden A., Slater H., Jang IK., Roa N., Pal S., Sarr FD., Faye J., Vigan-Womas I., Dieye Y., Cisse M., Domingo GJ., Niang M. (2025). Performance and usability evaluation of three LDH-based malaria rapid diagnostic tests in Kédougou, Senegal. *Parasites & Vectors*, 18 :280. doi :10.1186/s13071-025-06914 Santé.

[26]. Ogunfowokan O., Ogunfowokan B.A., Nwajei A.I. (2020). Sensitivity and specificity of malaria rapid diagnostic test (mRDT CareStat™) compared with microscopy amongst under five children attending a primary care clinic in southern Nigeria. *African Journal of Primary Health Care & Family Medicine*, 12 (1). Doi :10.4102/phcfm. v12i1.2212. License CC BY 4.0.

[27]. Bruneel F., (2025). Malaria treatment. University Diploma in Anti-Infective Therapies, Grenoble Alpes University, March 19, 2025. Intensive Care and Resuscitation Department, Versailles Hospital. Available at: https://www.infectiologie.com/UserFiles/File/formation/du/grenoble/f-bruneel-versailles-paludisme-du-tai-grenoble-2024-2025.pdf.

[28]. Domingo GJ., Niang M. (2025). Performance and usability evaluation of three LDH-based malaria rapid diagnostic tests in Kédougou, Senegal. Parasites & Vectors, 18 :280. doi :10.1186/s13071-025-0691.