

*Full Length Research Paper*

# Knowledge of patients and interest of Rapid Diagnostic Tests (RTDs) for uncomplicated malaria efficient management in community pharmacies of Côte d'Ivoire

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## Abstract

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For better management of malaria, WHO recommends early biological diagnosis for rapid treatment. In Côte d'Ivoire, due to difficulties associated with the use of microscopy in primary health care facilities, the biological diagnosis of malaria relies mainly on RDTs. Private pharmacies play an important role in the outpatient healthcare using RDTs to diagnose malaria. The aim of this study was to determine knowledge of patients and frequency of malaria cases using RDTs among patients in private pharmacies of Côte d'Ivoire. This cross-sectional survey was carried out from June to November 2020 among patients in three private pharmacies. Questionnaire was administered to individuals after informed consent to assess knowledge and collect sociodemographic data. Blood samples were taken from patients and the "ABON™ Plus Malaria P.f /Pan" RDT was performed on each sample. Of 450 subjects sampled, 33.3% (150/450) were RDTs positive. *Plasmodium falciparum* was the only species identified. The majority of the population (93.4%) revealed that the mode of transmission of malaria is mosquito bites. The main symptom of patients was fever (85.6%). The main ways of malaria prevention mentioned by patients were the use of insecticides (80%) and mosquito nets (73.5%). The majority of patients (74.6%) justified biological confirmation by detecting parasite in blood. This study shows the importance of confirming suspected cases of malaria in all contexts, in order to avoid misuse of anti-malarial drugs in pharmacies.

**Keywords:** Rapid diagnostic tests - uncomplicated malaria – private pharmacies.

## INTRODUCTION

Major endemic parasitic disease, malaria is caused by a protozoan of the genus *Plasmodium* transmitted by the bite of an infected female *Anopheles* (Danis and Mouchet, 1991). According to WHO's latest World malaria report 2024, there were an estimated 263 million cases and 597 000 malaria deaths worldwide. Approximately 95% of

the deaths occurred in the WHO African Region, where many at risk still lack access to the services they need to prevent, detect and treat the disease. In addition to the disruptions caused by COVID-19, the global malaria response has faced a growing number of threats. The COVID-19 pandemic has posed substantial challenges to the malaria elimination program as revealed by increasing incidence (World Health Organization, 2023).

In Côte d'Ivoire, malaria remains a major public health problem, accounting for 33% of outpatient consultations

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and a third of cases reported in health establishments (Ministère de la Santé et de la Lutte Contre le SIDA, 2016). Recently, the incidence rate of malaria in Côte d'Ivoire was 173.43 per 1000 in the general population and 440.97 per 1000 in children under 5 years old (Ministère de la Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle, 2021). In this situation, WHO recommends several control strategies, including early diagnosis and rapid treatment of malaria cases. The use of microscopy requires a source of electricity, reagents and heavy equipment, as well as qualified personnel for its implementation (World Health Organization, 2024). Rapid diagnostic tests (RDTs) are a response to the WHO's recommendations of early diagnosis, as they are simple, rapid and inexpensive diagnostic tools. Private pharmacies play an important role in the outpatient healthcare. As public health agents involved in the control and elimination of parasitic endemics, pharmacists must act in accordance with current recommendations by advising and educating patients about good practice in the use of medicines and disease prevention. Above all, they must educate the population in the reasonable use of medicines, particularly anti-malarial drugs, with a view to achieving the objective of eliminating this disease in Côte d'Ivoire (Angora *et al.*, 2011; Bedia-Tanoh *et al.*, 2023). The introduction of RDTs in pharmacies has offered hope of improving the management of malaria, by moving away from presumptive treatment of fever with antimalarial drugs towards targeted treatment of malaria based on biological diagnosis (World Health Organization, 2010). Abusive use of antimalarial drugs can lead to the selection of resistant plasmodial strains, is a risk for the occurrence of side effects due to antimalarial drugs and is also an additional financial burden for patients. The limited availability of RDTs in pharmacies, the lack of information on performance and quality control, as well as compliance and implications for the dispensing of antimalarial drugs to patients, are some of the gaps of the use of malaria RDTs in communities' pharmacies. The aim of this study was to determine the knowledge of patients and the frequency of malaria cases using RDTs among patients in private pharmacies of Côte d'Ivoire.

## MATERIEL AND METHODS

### Study design and setting

This cross-sectional study was carried out from June to November 2020 among patients from three private pharmacies in Abidjan, southern part and Daloa western part of Côte d'Ivoire.

For Abidjan settings, the survey took place in pharmacies in Yopougon and Cocody.

Yopougon is one of the ten municipalities of Abidjan and covers an area of 153.06 km<sup>2</sup> for a population of around 1,071,543 inhabitants. This municipality remains the largest in Abidjan and is located in the west of the city of

Abidjan, bordered to the north by the commune of Abobo and the town of Anyama; to the south by the Atlantic Ocean; to the east by Attécoubé and to the west by Songon. Most parts of Yopougon is made up of grouped housing built by parastatal and private real estate companies, as well as by large corporations, apartment buildings, communal courtyards, villages and their extensions. Cocody, the second site in Abidjan covers an area of 132 km<sup>2</sup> for a population of around 447,055 inhabitants. The city is located to the east of Abidjan, bordered to the north by the municipality of Abobo, to the south by the Ebrié Lagoon, to the east by Bingerville and to the west by the municipalities of Adjamé and Plateau. Cocody is a residential city, with a majority of villas and high- and medium-rise buildings. Cocody is also home to major economic, socio-economic, administrative and political infrastructures.

The third community pharmacy is located in Daloa, western part of Côte d'Ivoire. This city is the third largest one in Côte d'Ivoire, with a surface area of 5305 km<sup>2</sup> and an estimated population of 245,360. Daloa is located in central-western Côte d'Ivoire, 141 km from Yamoussoukro and 383 km from Abidjan, bordered to the north by the town of Vavoua, to the south by the town of Issia, to the east by the town of Bouaflé and to the west by the town of Zoukougbeu (Institut National de la Statistique, 2014).

**Figure 1** shows the study settings in Abidjan and Daloa.

### Study population sample size

Participants involved in the survey were patients who frequented community pharmacies for medical and/or dietary advice on pathologies and questions of well-being. The study included customers who came to the pharmacy for advice on anti-malarial treatment, a direct request for anti-malarial treatment without a medical prescription, or to ask for advice, and who had given their consent.

To determine the sample size, the following formula (Naing, 2003) was used:

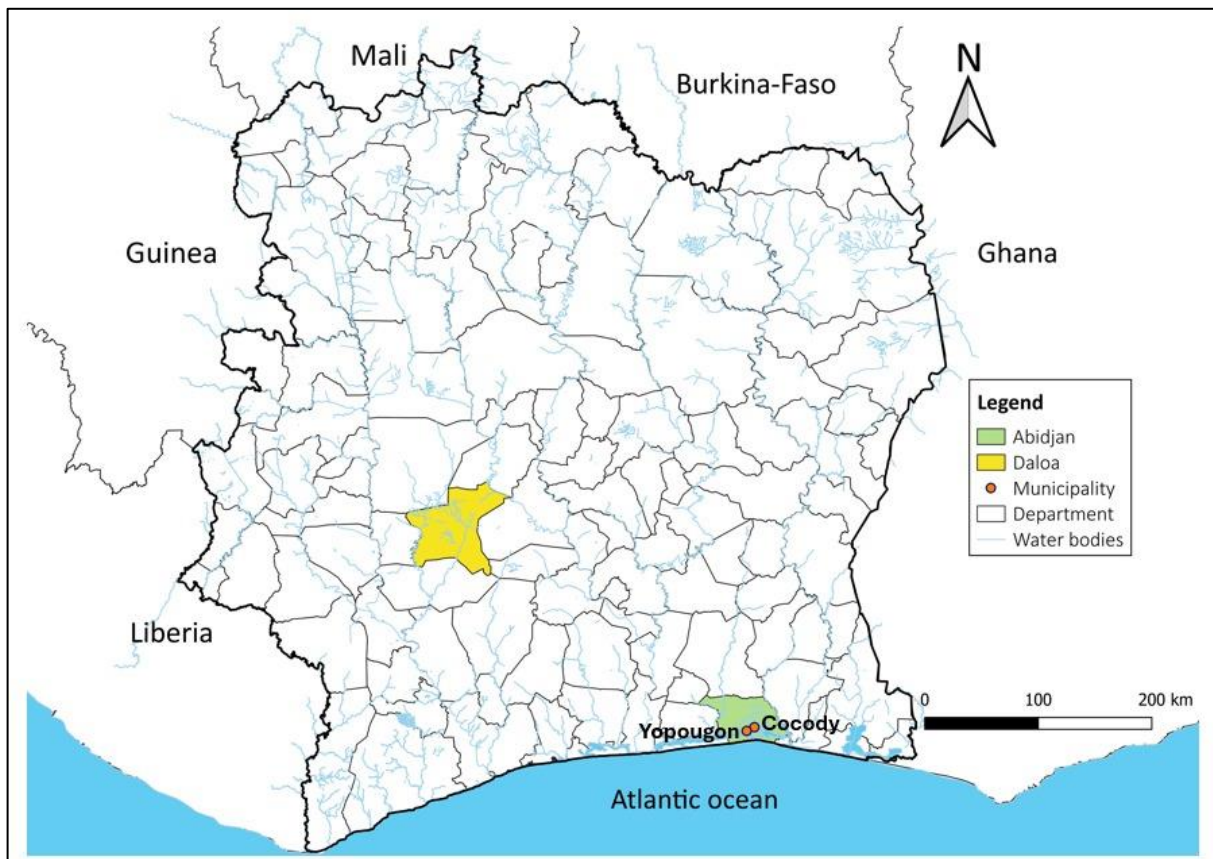
$$n = \frac{\left(\frac{\mu_{\alpha}}{2}\right)^2 P_n(q_n)}{d^2}$$

$P_n$ : prevalence of malaria in pharmacies set at 50% (we have no previous data on malaria in pharmacies);  $q_n = 1 - P_n$ ;  $d$ : alpha level (5%) at the confidence interval of 95%;  $u_{\alpha/2} = 1,96$ .

The resulting sample size was  $n = 150$  participants for each study site.

### Data collection and malaria RDT performing

Prior the survey, authorization was obtained from the National Union of Private Pharmacists of Côte d'Ivoire. The list of pharmacies in the study area was provided by the union of pharmacists. Patients who came to the pharm-



**Figure 1:** Study sites in Abidjan and Daloa.

acy for malaria treatment and did not have a prescription were included in the study. After interviewing the patient or their companion (if the patient is a minor), and if the symptoms indicate a suspicion of uncomplicated malaria, the patient or their companion is asked for their informed consent to participate in the study after a clear and simple explanation of the protocol. In addition, the pharmacists' oral consent was obtained prior to the start of the investigation. Once consent had been obtained, the patient or his or her representative was asked to complete a questionnaire about their knowledge on parasite, transmission mode, control strategies and practices on malaria, as well as information on the patient's socio-demographic aspects including symptoms and RDTs results.

Afterwards, the "ABON™ Plus Malaria P.f./Pan" RDT was performed on each patient using a capillary blood sample in accordance with hygiene rules. Approximately 5 µL of blood and 4 to 5 drops of diluent are used for testing, with a reading time of 15 minutes. This test is the product of an American multinational (ABBOTT Park, Illinois, in the United States). The ABON Plus® test uses an immuno-chromatography reaction. It comes in the form of a plastic cassette containing a nitrocellulose membrane to which two monoclonal antibodies are attached in two separate lines in the test zone: and specific to the *P. falciparum*-specific HRP II (Histidin-rich protein II) protein and to pLDH

(*Plasmodium* Lactate Dehydrogenase), common to all *Plasmodium* species (pan-specific). ABON™ Plus Malaria P.f./Pan Rapid Test Device is a detection of circulating antigens of *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae* in whole blood with sensitivity of 98% and specificity of 94% (Abbott, 2019). Patient was not charged for the RDTs, but was responsible for treatment if the test was positive. In case of negative RDTs examination, the diagnosis of malaria was not retained and another disease was explored.

### Statistical analysis

Data were analyzed using STATA version 14 software. Parameters such as proportions, mean, standard deviation, minimum and maximum were used to describe the study population. Percentages were calculated in relation to the total number of respondents per question. Responses to open ended questions were grouped into common themes. The relationship between two variables was tested with Pearson's Chi-square test or Fisher's exact test with a 5% risk of error.

### Ethical considerations

This study was conducted under the supervision of the Ivorian Pharmaceutical Regulatory Authority. Informed

**Table 1:** Sociodemographic characteristics of population and knowledge on malaria.

| Parameters                          | Total (n=450) | Percentage (%) |
|-------------------------------------|---------------|----------------|
| <b>Gender</b>                       |               |                |
| Male                                | 247           | 54.9           |
| Female                              | 203           | 45.1           |
| <b>Age (years)</b>                  |               |                |
| 0-5                                 | 59            | 13.1           |
| 6-15                                | 107           | 23.8           |
| 16-45                               | 242           | 53.8           |
| ≥ 45                                | 42            | 9.3            |
| <b>Occupation</b>                   |               |                |
| Unemployed                          | 34            | 7.6            |
| Public/private employee             | 92            | 20.4           |
| Artisan/trader                      | 26            | 5.8            |
| Student                             | 101           | 22.4           |
| Householder                         | 22            | 4.9            |
| Others*                             | 175           | 38.9           |
| <b>Transmission mode</b>            |               |                |
| Mosquito bite                       | 424           | 94.2           |
| Poor hygiene                        | 86            | 19.1           |
| Fatigue                             | 135           | 30.0           |
| Fatty food                          | 46            | 10.2           |
| Sunlight                            | 102           | 22.7           |
| <b>Strategies of vector control</b> |               |                |
| Praying of insecticide              | 189           | 42.0           |
| LLITNs                              | 100           | 22.2           |
| Environment sanitation              | 49            | 10.9           |
| <b>Mosquito bite exposure</b>       |               |                |
| Yes                                 | 384           | 85.3           |
| No                                  | 66            | 14.7           |
| <b>Ownership of LLITNs</b>          |               |                |
| Yes                                 | 209           | 46.4           |
| No                                  | 241           | 53.6           |
| <b>LLITNs use</b>                   |               |                |
| Yes                                 | 116           | 25.8           |
| No                                  | 334           | 74.2           |

\*Others: workers, farmers, breeders, etc.; LLITNs : long-lasting insecticide treated mosquito nets.

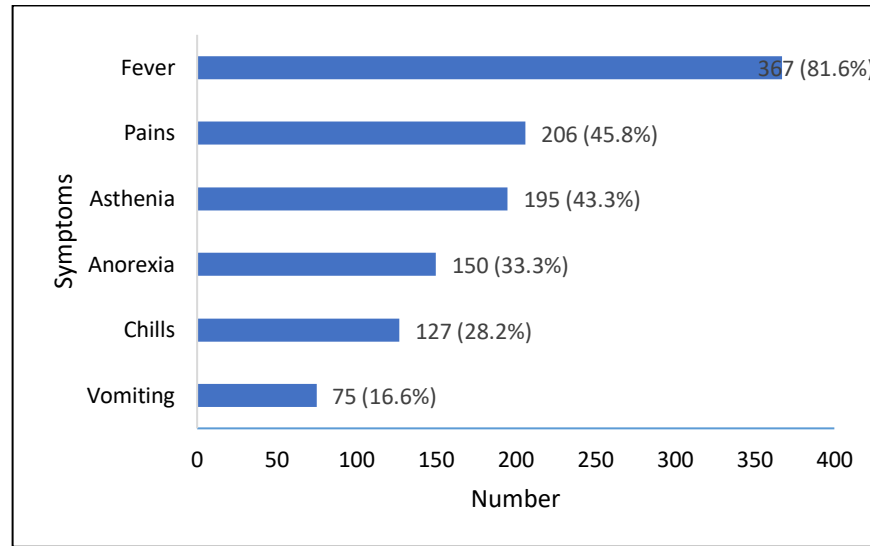
consent was obtained from patients or their legal guardians before inclusion. Patient information was kept confidential. Each person included in the study was assigned a serial number to maintain anonymity. Rapid diagnostic tests were provided free of charge to patients. However, if the test was positive, the patient was responsible for the cost of the proposed antimalarial treatment.

## RESULTS

### Characteristics of study population, knowledge and malaria symptoms

Of 450 participants in three community pharmacies 150 per pharmacy were included in the study. Most of them (54.9%) were male while 45.1% were female with a Sex-

ratio of 1.26. The mean age was 23.3 years (SD=16.2 years). Participants aged from 16 to 45 years old were the most involved at 53.8% while children aged 0-5 accounted for only 13.1% of the subjects included. The majority was student at 22.4% and a few (4.9%) was householders. The participants' knowledge assessment showed that mosquito bite is the main transmission mode of malaria with 94.2%. According to the strategies of vector control, insecticide spraying was frequently reported by the responders as prevention method of malaria. In addition, 22.2% has shown that the long-lasting insecticide treated mosquito nets (LLITNs) and environment sanitation was mentioned only at 10.9%. The majority (85.3%) of participants reported being exposed to mosquito bites in the workplace or at home. Of the 209 (46.4%) participants who owned a long-lasting insecticide treated mosquito net, only 116 (55.5%) mentioned that they actually used it for malaria prevention. **Table 1** shows the sociodemographic



**Figure 2:** Clinical signs of participants during the survey.

characteristics of study population and knowledge on malaria.

During the survey, the main clinical signs presented by patients were fever (81.6%), followed by pains (45.8%) and asthenia (43.3%). Others minor symptoms were described by participants, such as anorexia, chills and vomiting at 33.3%, 28.2% and 16.6% respectively (**Figure 2**). In addition to the clinical signs of malaria, patients mentioned that it was important to confirm the diagnosis of malaria, the main reasons being diagnostic certainty and the avoidance of self-medication.

### Malaria rapid diagnostic test results

The malaria RDTs were tested among all the participants included in this study. Of 450 participants, 150 were positive to the malaria test with an incidence of 33.3% (150/450). *Plasmodium falciparum* was the only one species identified, i.e. a specific index of 100% (150/150). Most of malaria positive cases were observed in Daloa, a city located in the west of Côte d'Ivoire ( $p=0.013$ ).

Nearly 75% of malaria cases were identified in children aged 0 to 15 years old. Thus, a statistically significant difference was observed between age and malaria incidence ( $p=0.001$ ). According to gender, female subjects were as affected as male, with no significant difference. Patients who reported using aerosol insecticides as malaria control tools were significantly more affected by malaria than those who reported using long-lasting insecticide treated mosquito nets and sanitation measures to control the disease ( $p=0.039$ ).

Population who reported owning long-lasting insecticide treated mosquito nets, as well as those who reported using them, were affected in the same incidence rate that who neither owned nor used this mosquito net ( $p>0.05$ ). Participants who did not use LLINs generally used

insecticides in aerosol form. **Table 2** presents the relationship between epidemiological parameters and RDT results.

### DISCUSSION

*Plasmodium* resistance to antimalarial drugs is a real threat in malaria-endemic areas. Early diagnosis and rapid treatment of cases are essential to reduce this resistance. In Côte d'Ivoire, RDTs are recommended in first-contact healthcare establishments. Private pharmacies are an important link in the management of malaria (Amankwa *et al.*, 2019), and often have RDTs available for diagnosis. This study evaluated the knowledge of patients on malaria and determined the incidence rate of malaria using RDTs in community pharmacies of Abidjan and Daloa in Côte d'Ivoire. The study included more male (54.9%) than female (45.1%). These results are similar to authors who reported in others countries a predominance of male (Wade *et al.*, 2012; Audu *et al.*, 2016). In contrast, female predominance has been observed in Abidjan (Bedia-Tanoh *et al.*, 2023). Participants aged 16-45 years old were the most represented (53.8%), while children aged 0-5 years accounted for 13.1%. This result differs from WHO reports which stated that those most exposed to malaria were pregnant women and children under 5 years old (World Health Organization, 2010). Our results could be explained by the fact that some parents of these children were very skeptical about the RDT management in community pharmacies. Often, parents prefer to send their children to hospital for malaria management because of the high risk of the severe form in this fragile group.

According to knowledge assessment, mosquito bite was the main transmission mode of malaria mentioned by participants. This shows that people visiting private pharmacies are well informed about malaria transmission



**Table 2:** Relationship between epidemiological parameters and RDT positivity.

| Parameters                          | Total | RTD – n (%) | RTD + n (%) | p-value |
|-------------------------------------|-------|-------------|-------------|---------|
| <b>RDT Result</b>                   | 450   | 300 (66.7)  | 150 (33.3)  | --      |
| <b>Study sites</b>                  |       |             |             | 0.013   |
| Cocody                              | 150   | 102 (68.0)  | 48 (32.0)   |         |
| Daloa                               | 150   | 87 (58.0)   | 63 (42.0)   |         |
| Yopougon                            | 150   | 111 (74.0)  | 39 (26.0)   |         |
| <b>Gender</b>                       |       |             |             | 0.837   |
| Male                                | 247   | 165 (66.8)  | 82 (33.2)   |         |
| Female                              | 203   | 135 (66.5)  | 68 (33.5)   |         |
| <b>Age (years)</b>                  |       |             |             | 0.001   |
| 0-5                                 | 59    | 26 (44.1)   | 33 (55.9)   |         |
| 6-15                                | 107   | 57 (53.3)   | 50 (46.7)   |         |
| 16-45                               | 242   | 180 (75.2)  | 60 (24.8)   |         |
| ≥ 45                                | 42    | 34 (80.9)   | 7 (19.1)    |         |
| <b>Transmission mode</b>            |       |             |             | 0.076   |
| Mosquito bite                       | 424   | 280 (66.0)  | 144 (34.0)  |         |
| Poor hygiene                        | 86    | 65 (75.6)   | 21 (24.6)   |         |
| Fatigue                             | 135   | 80 (59.3)   | 55 (40.7)   |         |
| Fatty food                          | 46    | 33 (71.7)   | 13 (28.3)   |         |
| Sunlight                            | 102   | 60 (58.8)   | 42 (41.2)   |         |
| <b>Strategies of vector control</b> |       |             |             | 0.039   |
| Praying of insecticide              | 189   | 129 (68.3)  | 60 (31.7)   |         |
| LLITNs                              | 100   | 59 (59.0)   | 41 (41.0)   |         |
| Environment sanitation              | 49    | 31 (63.3)   | 18 (36.7)   |         |
| <b>Ownership of LLITNs</b>          |       |             |             | 0.324   |
| Yes                                 | 209   | 136 (65.1)  | 73 (34.9)   |         |
| No                                  | 241   | 164 (68.0)  | 77 (32.0)   |         |
| <b>LLITNs use</b>                   |       |             |             | 0.648   |
| Yes                                 | 116   | 75 (64.7)   | 41 (35.3)   |         |
| No                                  | 334   | 225 (67.4)  | 109 (32.6)  |         |

RDT: rapid diagnostic test; LLITNs: long-lasting insecticide treated mosquito nets.

mode in Côte d'Ivoire, as in previous studies (Angora *et al.*, 2011; Ganfon *et al.*, 2017; Nsengimana *et al.*, 2023). The insecticide praying, long-lasting insecticide treated mosquito nets (LLITNs) and environment sanitation known as principal strategies to avoid malaria were frequently reported elsewhere in other studies (Elhag and Sulaiman, 2021; Ousmane *et al.*, 2023; Nemat *et al.*, 2024). This result could be justified by the awareness campaigns organized by the Ministry of Health and also under the supervision of the National Malaria Control Program (NMCP). These results are in line with the WHO vector control strategy, which recommends that the main means of malaria control should be the use of insecticides and LLITNs (World Health Organization, 2023). The mosquito bites exposure related to the workplace or at home were declared in our study and few participants (55.5%) actually used long-lasting insecticide treated mosquito net. Our

results rare similar to those from author who obtained an effective use rate of mosquito treated net at 46.27% (Komboigo-Savadogo *et al.*, 2017). The effective use of long-lasting insecticide-treated nets remains a challenge for all those at risk of malaria. In endemic zones where malaria transmission is high, children and pregnant women receive a long-lasting insecticide-treated net from the start of their pregnancy. In Côte d'Ivoire, the national campaign for the free distribution of impregnated mosquito nets has come to a successful conclusion. All health districts were involved, improving access for all households (Programme National de Lutte contre le Paludisme en Côte d'Ivoire, 2024). WHO recommendations call for their effective use for better malaria control (World Health Organization, 2023). In this study, the main clinical signs presented by patients were fever (81.6%), followed by pains (45.8%) and

asthenia (43.3%). Malaria symptoms can be similar to cold or flu symptoms, so it might be hard to tell what you have at first. Commonly, the patient initially presents with a combination of the many symptoms (Centers for Disease Control and Prevention, 2024). Biological examen is the main way to confirm malaria cases for a better management and the avoidance of self-medication.

Our study revealed that most patients interviewed in private pharmacies mentioned that performing RDTs before dispensing antimalarials helped reduce antimalarial use in others with malaria-like symptoms. These results are corroborated by some earlier studies (Rusk *et al.*, 2013; Nsengimana *et al.*, 2023). Similar study showed that morality of participants recognized the importance of confirming a malaria diagnosis before treatment (Obi *et al.*, 2019; Kassi *et al.*, 2024). Thus, the use of RDTs promotes the rational use of antimalarial drugs.

In the current study, 150 patients tested positive, representing a malaria incidence of 33.33%. So, there are 66,7% of people who asked for malaria treatment when they don't have the disease. Pharmacists gave often malaria medication base on clinical symptoms without confirmation. This could increase the risk of malaria drugs resistance, the risk of deterioration of patient's health who suffer of over disease and the risk of secondary effect by the use of drugs (Hyde, 2007).

The only plasmodial species found during the study was *Plasmodium falciparum*. Our results are similar to those of a study carried out (Koné *et al.*, 2015) in Abidjan. *Plasmodium falciparum*, the only species identified in a study confirming its involvement in the fatal form of malaria, is the species most commonly encountered in Côte d'Ivoire (Konaté-Touré *et al.*, 2024). Thus, the National Malaria Control Program (NMCP) should involve private pharmacies in malaria management for suspected malaria (Onwujekwe *et al.*, 2015). We noted that malaria infestation in children aged 0 to 15 years old were significantly higher than in adults. This could be explained first and foremost by the refusal of parents accompanying the youngest children to carry out the RDT (thinking that the test was an anti-covid 2019 vaccine), which could influence the participation by the youngest children (World Health Organization, 2023). In addition, low immunity in children under 5 years of age could partly explain this higher infestation rate. The use of RTDS in pharmacies can minimize financial and geographical barriers to early diagnosis of malaria, especially in areas where access to healthcare facilities is limited. Early identification through rapid diagnostic tests facilitates prompt intervention for patients, which can optimize health outcomes and reduce long-term treatment costs (Onwujekwe *et al.*, 2015).

Malaria transmission modes and vector control strategies had a significant impact on malaria incidence in the study population. Patients who used aerosol insecticides as malaria control tools were significantly more affected by malaria than those who reported using long-lasting insecticide treated mosquito nets and sanitation

measures. Climatic and environmental conditions are more favorable to the use of insecticides. However, WHO states that the main vector prevention techniques are still those involving the use of LLINs (World Health Organization, 2023). Thus, the use of insecticides in aerosol form remains an alternative means of protection, but LLINs are still the most reliable means of protection against malaria, pending the widespread introduction of malaria vaccines (Komboigo-Savadogo *et al.*, 2017; Ministère de la Santé, de l'Hygiène Publique et de la and Couverture Maladie Universelle, 2021).

This study has some limitations that should be taken into account in future research. The use of rapid diagnostic tests (RDTs) for malaria in pharmacies reveals a number of constraints, both related to the tests themselves and to the situation in which they are implemented. Thus, the small sample size may not accurately reflect all pharmacies in the study, constituting a selection bias. The pharmacies considered may have specific attributes such as location, staff qualifications, and workload that do not represent the variety of pharmaceutical practice.

## CONCLUSION

Rapid diagnostic tests for malaria have been making great strides in biology for several years. Unlike conventional diagnostic tests, RDTs for malaria is a real advantage for patients in diagnosis at short space of time. This study analyzed the role of community pharmacies in the management of uncomplicated malaria in Côte d'Ivoire. In view of the results, only 33% of the people received in community pharmacies for suspected malaria in our context actually had malaria. In three out of four cases, over-treatment with anti-malarial drugs was avoided. This led to effective management of patients, while preserving anti-malarial drugs. In addition, people were able to save money and time in the management of their disease. Integrating the use of RDTs in private pharmacies to confirm cases of malaria before malaria treatment is a best practice in the strategy for managing this disease at national level. Future studies involving a large number of selected pharmacies will reveal the actual extent of TDRs use.

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## CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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