Malaria in the Republic of Guinea 2022–2023: costs associated with the care pathway from the patient's perspective

Elhadj Marouf Diallo[1,2*], Fatoumata Bintou Traore[1], Alice Langlet[2], Letitia A. Onyango[3], Marie Blanquet[2], Bienvenu Salim Camara[4], Sidikiba Sidibe[1], Alioune Camara[1,5] and Laurent Gerbaud[2]

Abstract

Background Access to safe, financial affordable health care is a key factor in reducing health disparities. The malaria is a major public health issue, with significant economic implications in Guinea where the free malaria care services were introduced in 2010. This paper analyzes the costs associated with the care pathway for malaria patients in the Republic of Guinea.

Methods An analysis of the costs associated with malaria disease was conducted using data from a cross-sectional survey on the determinants of malaria care pathway between December 2022 and March 2023. The data were collected in health facilities and at community health workers. According to the patient's perspective, Time-Driven Activity-Based Costing (TDABC) and micro-costing approaches were used to assess the costs associated with care-seeking, cases management, and income loss.

Results A total of 3300 patients were recruited in 60 health facilities. The majority were in urban areas (64.8%). One third of the patients were children under five years old. Over half of the patients or caregivers were without formal education, and most households were headed by husbands (78.5%). The median monthly income of the head of households was $116.0. Furthermore, after diagnosis, 25.5% of cases were uncomplicated malaria, 19.2% were complicated, and 52.2% were malaria associated with other diseases. Globally 41% of cases were on their first care pathway. The costs of care-seeking varied according to type of malaria, from $3.5 and $13.5 respectively for uncomplicated and complicated cases. The median direct costs of case management at health facilities were $7.3 (IQR: $4.1,13.3) for uncomplicated and $30.5 (IQR: 15.7, 51.4) for complicated cases. The total costs associated with the global care pathway differed across types of malaria and age groups, with median costs estimated at $17.4 (IQR: 6.7, 34.8) for uncomplicated cases and $43.5 (IQR: $ 19.7, 74.0) for complicated malaria. A delay in appropriate care-seeking accounted for 19% of the costs incurred by malaria patients in Guinea ($p < 0.001$).

Conclusion Despite the introduction of free malaria prevention services, malaria patients or their caregivers continue to incur costs and loss of income. An approach to selective, free and affordable flat-rate costs could ensure the financial viability of health facilities and reduce out-of-pocket expenses. The next research will focus on the impact of

*Correspondence:
Elhadj Marouf Diallo
elhadjmaroufd@yahoo.fr; Elhadj_Marouf.DIALLO@doctorant.uca.fr

Full list of author information is available at the end of the article

free selective and flat-rate pricing on out-of-pocket expenses, and the analysis of the perception of the malaria care services by care providers and users.

Keywords Malaria, Care pathway, Out-of-pockets expenses, Income loss

Introduction

The third Sustainable Development Goal aims to achieve universal health coverage through the provision of essential medicines and safe, affordable and prompt health services [1]. This vision is of the highest importance, particularly in sub-Saharan Africa, where inequalities in access to health and social protection services persist. Flagship disease control programs (malaria, HIV, tuberculosis) have achieved results in terms of primary and secondary prevention. However, their verticality of these approaches has been shown to have limitations, and the solutions currently being considered are the integration of health system strengthening into subsidies, as well as integrated disease management at community level, particularly among children [2, 3].

Over the past two decades, there have been significant advance in the fight against malaria, a major public health issue that has seen a rise in post-Covid-19 cases in the World Health Organization (WHO) Africa Region [4]. In 2022, it accounted for 94% of cases and 95.3% of deaths reported worldwide [5]. The direct costs associated with case management are significant, especially in the case of multiple pathways for malaria care. In some countries, 4.2% of patients resell goods to finance malaria care, with average medical costs reaching $29.50 [6, 7]. In 2017, the costs associated with uncomplicated malaria were estimated at $503 million in the Democratic Republic of Congo [8]. In endemic areas, malaria maintains a vicious circle amplified by economic factors that hinder early and appropriate care-seeking, which is essential to preventing complicated forms of malaria and reducing the number of deaths [8–13]. The care pathway for malaria patients is characterized by multiple recourse and non-conventional methods, including self-medication [6, 9, 14, 15]. This behavior leads to a multiplication of out-of-pocket expenses for the patient or their household.

In Guinea, malaria is a stable endemic with peaks during the rainy season, accounting for almost 47.5% of hospital morbidity [16]. It induces substantial workload and generates cash flow for health facilities. The direct costs associated with malaria cases represent a considerable financial burden for patients in a country where 43.7% of the population live below the poverty line, with a health budget of 6.4% in 2022, below the Abuja target of 15% [17–19]. Furthermore, the associated non-medical costs, indirect costs (loss of income) are often underestimated. While there are data on the epidemiological impact of malaria, there is a significant knowledge gap in the costs borne by communities. Reliable data on the costs (out-of-pocket expenses, loss of income) associated with case management is essential for the development of effective secondary prevention strategies. The aim of this paper was to analyze the costs associated with the care pathway of malaria patients in Guinea from the patient's perspective.

Methods
Study setting
Guinea is a coastal country in West Africa, with an area of 245,857 km^2. It is divided into eight administrative regions including a special region of Conakry. In 2022, the population was estimated at 13 million with a gross domestic product of $ 1,515.2 per capita [17, 20]. The provision of care is organized in a pyramidal manner. At the primary level, the community continuum (comprising community health workers and health posts) and health centers. In 2021, there were 2,051 health posts and 423 health centers. At the secondary level, there are referral hospitals which include 26 district hospitals, eight regional hospitals and 11 communal medical centers. They also serve as a reference for the facilities of the primary level. At the tertiary level, there are three national hospitals that make up the Conakry University Hospital [19]. The private healthcare sector is present at all three levels of the health pyramid and is subject to less regulation. The country's private healthcare sector comprises more than 606 facilities, 110 of which are integrated by the National Malaria Control Program.

In each administrative region, one health district was randomly selected. The disparity in malaria prevalence between the eight administrative regions (less than 1% in Conakry and 30% in Nzerekore) motivated this sampling. However, two districts were sampled in the Nzerekore region due to the size of the region (six health districts) and the prevalence of malaria (30%). In total, nine health districts were selected (Fig. 1: Maps of health district selected).

In each health district, the referral hospital (district, or national) was selected. Subsequently random sampling was carried out to select one private facility integrated by the National Malaria Control Program (NMCP), one urban health center, two rural health centers, two health posts and four community health workers. At referral hospitals, the emergency, internal medicine and pediatrics units were selected as survey sites because of their use by malaria patients. For health centers, health posts and private health facilities, curative and prenatal consultation units were selected.
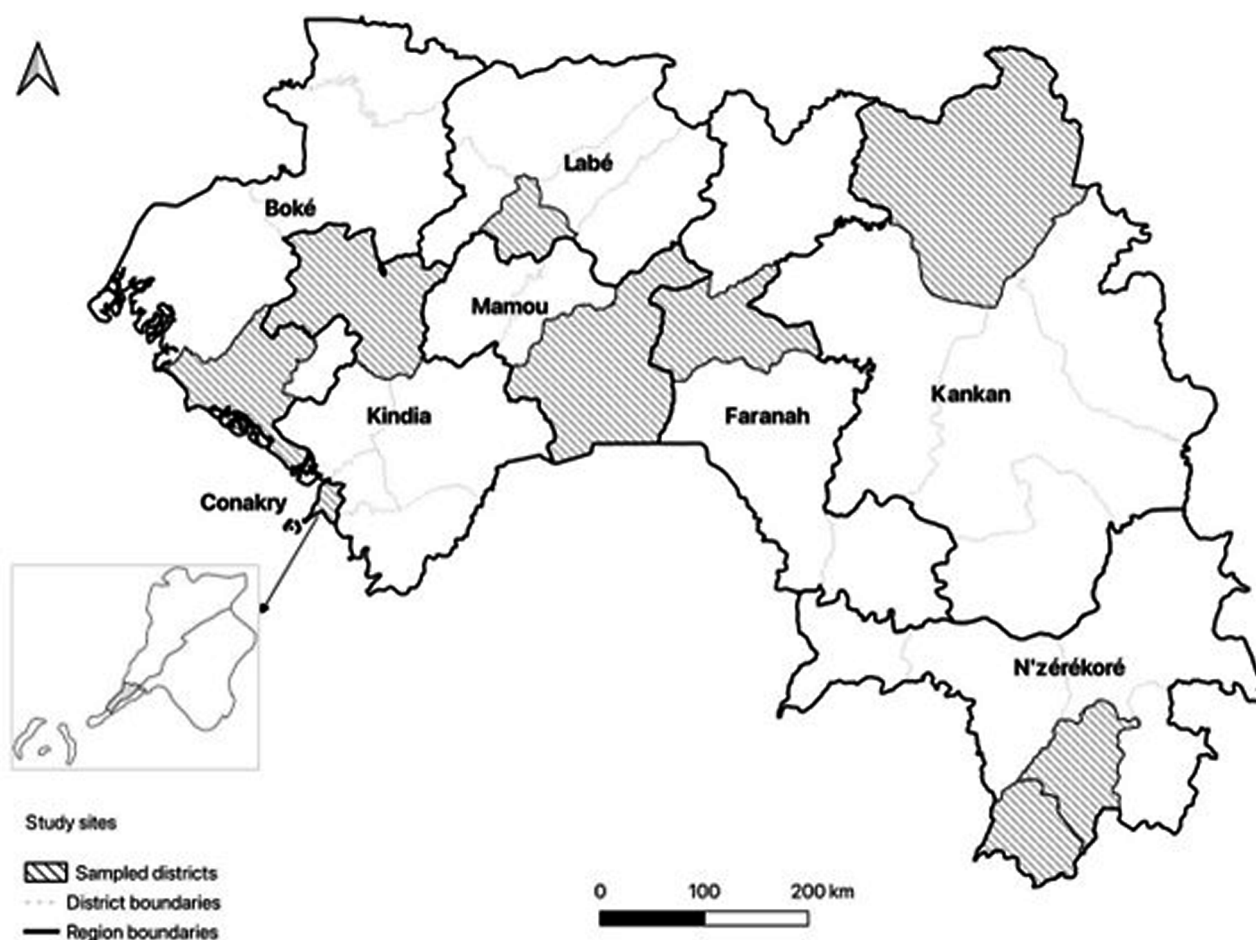
Fig. 1 Maps health district sampled

Study design

This is an analysis of the costs of malaria cases management in Guinea from the patient's perspective. The data was obtained from a cross-sectional survey carried out between December 2022 and March 2023 in health facilities and among community health workers.

Study population

The sample is constituted by individuals diagnosed with malaria by rapid diagnostic tests (RDTs) or microscopy, or both at public and private health facilities, as well as at the community level. The minimum sample size was estimated at the health district level and is determined by Schwartz's formula ($n = \frac{z^2 * pq}{d^2}$) [21] with (i) z representing the confidence level at 1.96 (95% CI), (ii) p the proportion of early seeking advice and care at 32% (Malaria Indicators Survey 2021) and a caution set at 5%. The minimum sample size per district was 334 patients distributed among the different levels of the health care system. The minimum sample size at the national level (N=n*9) initially defined was 3,009 malaria patients.

In each of the health facility survey units, patients diagnosed with malaria during the survey period were recruited to take part in the study. An exhaustive recruitment of malaria patients who had obtained their medication (in a day clinic or hospitalized) in the selected units had made. Children were recruited together with their caregivers. All patients who gave permission after verbal informed consent were recruited to take part in the study.

Data collection

The data were collected from the patients and caregivers using a tested and validated structured questionnaire. The data collectors were undergraduate students at the end of their medical cycle and master's degree students. The data collectors were trained to carry out the interview face-to-face before the start of data collection. The data included socio-demographic characteristics such as age group (under five years old, five years and over), gender, residence area (rural or urban), marital status (single, married or divorced), education level, profession of patient or caregivers, administrative region, ethnic group, head of household monthly income, relationship for

those under 18 years of age and people assuming costs of care pathway.

The care-seeking behavior included the access of health services according to the type of health facilities of recruitment (private facility, district hospital, health centers, health posts and university hospital), the first actions taken in response to illness (health facilities, health workers, self-treatment, traditional healer, religious healer) and number of care pathways before treatment (one, two, three and more).

According to the medical records, the type of malaria (uncomplicated, complicated, malaria and pregnancy, malaria and other diseases) diagnosed by health care providers and type of laboratory confirmation (RTD, Microscopy, both and other exams) were collected.

The duration of health care-seeking was time spent between the onset of symptoms and access to a healthcare facility and collected in hours for each patient. The associated costs of care pathway were collected according to the fees of transportation, of drugs, laboratory exams and other expenses. The transportation fees were costs from household to healthcare facility (fees paid to a third party or the equivalent in fuel used from the household to the care facility). The cost of drugs included anti-malarial drugs and adjuvant drugs used to resolve the clinical and biological manifestations of different forms of malaria. The costs of laboratory exams included microscopy, and other biological tests fees. The other expenses included food, administration fees or any other expenses incurred during the care pathway. These were declared by the patient as out-of-pocket expenses.

Data analysis
The data was extracted from the Open Data Kits support in Excel format, the processing and analysis, were carried out under R software 4.3.2 (RStudio 2023.12.0+369). The expenses incurred were collected in Guinean Franc (GNF) from the declarations of each patient or caregiver. The conversion rate to US dollars was $1=8624.28 GNF. A descriptive analysis was conducted of socio-demographic characteristics, clinical manifestations of the disease and the number of cares pathways used. The median and the interquartile range (IQR) were defined for continuous variables (age, monthly income, cost associated). Bivariate analyses were performed to identify clinical differences between patients who had one or two or more care pathways.

Assessing the costs associated with malaria
Time-Driven Activity-Base Costing and Micro Costing [22], were used to determine the costs associated with the care pathway for malaria patients. In uncomplicated cases, the required treatment duration is three days, however the duration of treatment may be affected by various

factors, including the patient's care-seeking behavior and the stage of the disease. We therefore proceeded to map the care pathway, the option used of each care pathway, and the time spent at each stage of the pathway. As the cost data did not follow a normal distribution, non-parametric tests were used to perform analyze, including the Wilcoxon-Mann-Whitney and Kruskal-Walli's sum rank tests. Graphs were produced using R software (with the ggplot2 package) to visualize the distribution of costs. The equations used were as follows:

$$C_{ass} = \sum (DC + IC) \qquad (1)$$

- C_{ass}: Costs associated.
- DC: Direct Costs associated with malaria.
- IC: Indirect cost or loss of income.

$$DC = \sum_{i=1}^{n} (medical + non\,medical\,cost) \qquad (2)$$

- i = number of pathways.

$$IC = \left(\frac{monthly\,income}{26} \right) * \Delta \qquad (3)$$

- Δ: Time spent seeking care and 26 (average number of days worked in the month).

$$\Delta = \sum_{i=1}^{n} T_i \qquad (4)$$

- T_i = Duration care-seeking each recourse.

Direct cost
Firstly, the median direct costs (medical and non-medical) and their IQR associated for all patients who used at least two care pathways were performed. In this stage, the direct costs of seeking conventional or non-conventional care were determined. Subsequently, in the second step, the direct costs associated with case management at the health facility surveyed were performed. For each of the components (transportation, other costs, laboratory, and drugs), a median and IQR was calculated. Moreover, the direct medical and non-medical costs were stratified according to the types of malaria, the age group (under five years old, five years and over), the level of the health facility and area. The direct costs of the care pathway were defined as the costs associated with care-seeking and the costs of malaria case management at the health facilities surveyed.

Loss of income

According to the results of equation four (Overall of care-seeking duration), the loss of income (Eq. 3) associated of care pathway were determined for each patient. For loss of income, only patients or caregivers who declared a monthly continuous income were included. These indirect costs were estimated by the time spent seeking care was multiplied by the reported daily income. The costs were stratified according to age group, area and diagnostic variable.

Finally, we determined the costs associated with malaria care by summing up the costs of care pathway and the loss of income for each patient. However, the cost of the production of care services by providers in health facilities has not been analyzed due to the number of practitioners involved according to the descriptive results and their different salary categories.

Ethics The study was approved by the National Ethics Committee for Health Research of Guinea (registered reference #151/CNERS, 2022). This study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from each patient or caregiver prior to data collection.

Results

Sample socio-demographic characteristics description

A total of 3300 patients were interviewed in 60 health facilities at different levels of the health pyramid throughout the country. Most of the patients 2138 (64.8%) lived in urban areas. 34% were under five years old with a median age of 24 months (IQR: 16 and 36), 1172 (35.5%) of patients under 18 years of age were accompanied by their mothers. Regarding the level of education, 1749 (53,0%) did not report any formal education, while 1123 (34.0%) had a liberal profession (patient or caregiver). Of those surveyed, 2592 (78.5%) belonged to households headed by the husbands. The median monthly income of the head of household was $116.0 (IQR: 69.6 and 173.9). Overall, 1337 (40.5%) and 1423 (43.1%) were respectively on their first and second care pathway (Table 1).

A total of 1353 (41,0%) patients met with three practitioners (physician, nurse, and health technician agent) during diagnosis and treatment. For biological diagnostic tests, 1654 (50.1%) received Rapid Diagnosis Test (RDT), 443 (13.4%) received microscopy (blood smear test) and 274 (8.3%) received RDT, microscopy and other complementary biological tests with significant differences between those under five years old and those aged five years and over ($p < 0.001$). The proportions of RDT usage were 45.5% (5 (95% CI 42.7% − 48.5%) and 52.5% (95% CI 50.4% − 54.7%) among those under 5 years old and the second group, respectively. The forms of malaria diagnosed by health care providers were 843 (25.5%), 635 (19.2%) and 1756 (53.2%) respectively for uncomplicated malaria, complicated malaria and cases associated with other diseases. A total of 3219 (97.5%) of the patients reported receiving their medication. For antimalarials drugs, 1439 (43.6%) of patients received artemisinin-based combination therapies (ACTs) oral route, without association with other forms. In contrast, 522 (15.8%) patients received ACTs oral route in combination with an injectable form. Moreover, 1391 (42.2%) of the patients, antibiotic and an analgesic (antipyretic) were prescribed with antimalarials. For 1803 (54.6%), the out-of-pocket expenses associated with care were covered by the husband (or father), 525 (15.9%) by the patient and 109 (3.30%) by insurance (Additional file 1a).

According to the care pathway number, among the patients with uncomplicated malaria 47.9% (CI95% 44.5-54.4%) had used only one care option. However, those with complicated forms 65.4% (CI 95% 61.5 − 69.0%) used two or more care pathways. For the pregnant women with diagnosed malaria, 60.6% (CI95% 47.8 − 72.2%) had used only one care option. The differences observed between the forms of malaria and the number of cares pathway used were significant ($p < 0.001$). (Additional file 1b).

The median time from onset of symptoms to contact with the survey health facility was 72 h (IQR: 48, 96 h). This duration varied according to the age group and the type of malaria diagnosed by the service provider.

Costs of care-seeking (before the survey)

A total of 1963 (59.5%) of patients had used two or more care options. In this group, the costs associated with seeking care varied, depending on the type of malaria and cost components. The initial option used by patients were either conventional (public or private health facilities or community services) or not (self-medication, traditional healer, or religious healer). The first option used by this group was non-conventional for 1296 (66.0%), mainly self-medication and traditional healers. The median direct cost associated with this non-conventional option was $1.7 (IQR: 0.6, 4.1) mainly associated with health products. In addition, during care seeking, a total of 1666 (84.9%) patients reported out-of-pocket pockets expenses. The median direct cost associated with care-seeking for uncomplicated cases of malaria was $3.5 (IQR: 0.7, 13.3) and complicated cases, the median direct cost was $13.5 (IQR: 3.5, 35.9). The median costs of care-seeking for malaria cases associated with another pathology were $8.1 (IQR: 1.7, 35.9) and with pregnancy $9.0 (IQR: 5.2, 19.7) A significant portion of the direct costs of seeking care were medical.

The examination of these out-of-pocket expenses by age group revealed the variations according to the type of malaria diagnosed by health care providers. The under

Table 1 Socio-demographic characteristics of the 3300 malaria cases recruited

	Under five, N = 1,132	Five and over, N = 2,168	Overall, N = 3,300
Natural region			
Lower Guinea	268 (23.7%)	811 (37.4%)	1,079 (32.7%)
Upper Guinea	338 (29.9%)	401 (18.5%)	739 (22.4%)
Middle Guinea	231 (20.4%)	515 (23.8%)	746 (22.6%)
Forest Guinea	295 (26.1%)	441 (20.3%)	736 (22.3%)
Area			
Urban	735 (64.9%)	1,403 (64.7%)	2,138 (64.8%)
Rural	397 (35.1%)	765 (35.3%)	1,162 (35.2%)
Under -five years old (median, IQR)	24.0 (12.0, 36.0)	-	24.0 (12.0, 36.0)
Five years and over (median, IQR)	-	23.0 (12.0, 37.0)	23.0 (12.0, 37.0)
Relationship			
Father	283 (25.0%)	273 (12.6%)	556 (16.8%)
Mother	788 (69.6%)	384 (17.7%)	1,172 (35.5%)
Other members	61 (5.4%)	105 (4.8%)	166 (5.0%)
Civil autonomy	0 (0.0%)	1,406 (64.9%)	1,406 (42.6%)
Education level			
No education	658 (58.1%)	1,091 (50.3%)	1,749 (53.0%)
Elementary level	189 (16.7%)	312 (14.4%)	501 (15.2%)
Secondary level	135 (11.9%)	282 (13.0%)	417 (12.6%)
High school	94 (8.3%)	285 (13.1%)	379 (11.5%)
University	56 (4.9%)	198 (9.1%)	254 (7.7%)
Profession			
Public servant	44 (3.9%)	131 (6.0%)	175 (5.3%)
Liberal profession	415 (36.7%)	708 (32.7%)	1,123 (34.0%)
Farmer	201 (17.8%)	356 (16.4%)	557 (16.9%)
Student	50 (4.4%)	200 (9.2%)	250 (7.6%)
Housewife	344 (30.4%)	484 (22.3%)	828 (25.1%)
Others	78 (6.9%)	289 (13.3%)	367 (11.1%)
Marital status			
Married	1,065 (94.1%)	1,726 (79.6%)	2,791 (84.6%)
Single	50 (4.4%)	323 (14.9%)	373 (11.3%)
Divorced	5 (0.4%)	24 (1.1%)	29 (0.9%)
Widower	12 (1.1%)	95 (4.4%)	107 (3.2%)
Head of household			
Husband	1,027 (90.7%)	1,565 (72.2%)	2,592 (78.5%)
Wife	38 (3.4%)	70 (3.2%)	108 (3.3%)
Co-management	6 (0.5%)	15 (0.7%)	21 (0.6%)
Others	61 (5.4%)	518 (23.9%)	579 (17.5%)
Ethnic group			
Peul	439 (38.8%)	979 (45.2%)	1,418 (43.0%)
Malinke	340 (30.0%)	477 (22.0%)	817 (24.8%)
Soussou	104 (9.2%)	298 (13.7%)	402 (12.2%)
Guerze	162 (14.3%)	236 (10.9%)	398 (12.1%)
Toma	20 (1.8%)	43 (2.0%)	63 (1.9%)
Kissi	10 (0.9%)	31 (1.4%)	41 (1.2%)
Others	57 (5.0%)	104 (4.8%)	161 (4.9%)
Head household monthly income $ (median, IQR)	116.0 (63.8, 173.9)	121.7 (69.6, 173.9)	116.0 (69.6, 173.9)
Head household monthly income $			
No income	24 (2.1%)	66 (3.0%)	90 (2.7%)
Under 64	355 (31.4%)	611 (28.2%)	966 (29.3%)
64–116	346 (30.6%)	673 (31.0%)	1,019 (30.9%)
117–348	324 (28.6%)	700 (32.3%)	1,024 (31.0%)
349–581	59 (5.2%)	89 (4.1%)	148 (4.5%)

Table 1 (continued)

	Under five, *N* = 1,132	Five and over, *N* = 2,168	Overall, *N* = 3,300
582 and over	24 (2.1%)	29 (1.3%)	53 (1.6%)
Number recourse used			
One	434 (38.3%)	903 (41.7%)	1,337 (40.5%)
Two	470 (41.5%)	953 (44.0%)	1,423 (43.1%)
Three and over	228 (20.1%)	312 (14.4%)	540 (16.4%)

five years old group the median cost of care-seeking was $3.5 (IQR: 0.7, 12.7) for uncomplicated cases and $12.8 (IQR: 3.2, 41.6) for complicated cases. Among five years old and over group, these costs were respectively $3.6 (IQR: 0.6, 13.8) and $13.6 (IQR: 3.5, 33.3) (Fig. 2a).

According to the area, higher costs observed an urban area. For the uncomplicated and complicated cases, respectively the median direct costs of care-seeking were $8.7 (IQR: 2.0 and 20.5), $16.8 (IQR: 4.1 and 38.3) in urban setting, $1.2 (IQR: 0.6, 5.2), $4.6 (IQR: 1.2, 13.9) in rural areas (Fig. 2b).

Costs of case management (during survey)

Most patients or caregivers surveyed incurred a direct medical or non-medical cost during their care at the health facilities. A total of 3218 (97.5%) respondents spent money, with 799 (94.8%) for uncomplicated forms and 625 (98.2%) for complicated cases.

The median non-medical costs associated with the uncomplicated form were $1.7 (IQR: 1.2, 2.9) and $ 6.3 (IQR: 2.3, 13.9) for complicated cases. The medical costs associated with both forms were significantly higher $5.2 (IQR: 2.9, 11.0) and $23.8 (IQR: 13.3, 41.7), respectively. Overall, the median direct cost (medical and non-medical) associated with the management of uncomplicated malaria was $ 7.3 (IQR: 4.1, 13.3) and $ 30.5 (IQR: 15.7, 51.4) for complicated cases (Table 2).

Out-of-pocket expenses also differed depending on the level of the health facility and area. At the health center level, the median direct costs were $ 6.5 (IQR: 4.1, 10.7) for uncomplicated cases, $ 11.0 (7.0, 16.2) for severe forms (which require pre-referral treatment at this level according to the national malaria case management guidelines). The highest direct costs (medical and non-medical) were observed at the district hospital level with $14.6 (IQR: 7.6 and 23.0), $39.4 (IQR: 23.7, 62.5) respectively for both forms. At the university hospital with more advanced technical equipment the median costs of malaria cases management were respectively $15.5 (IQR: 8.7, 30.1) for uncomplicated cases and 39.4 (27.0, 62.9) for complicated malaria. The median costs observed in rural areas were $5.2 (IQR: 2.7, 9.8), 11.7 (IQR: 7.0, 21.2) for uncomplicated and complicated cases. In urban areas the median costs were higher with $8.8 (IQR: 5.9, 16.2), $34.2 (IQR: 19.4, 57.0) for both forms of malaria.

The out-of-pocket expenses associated with cases of malaria combined with other diseases were higher, mainly due to the additional tests and drugs required, as well as the adaptation of care for patients. A total of 1729 (98.5%) of patients with malaria combined with another pathology incurred costs during their visit to the health facility. The median direct medical costs were $16.8 (IQR: 7.0, 31.1) for malaria associated with other diseases and $17.4 (IQR: 6.4, 25.7) for malaria in pregnant women. By adding direct non-medical costs, it is possible to assess out-of-pocket expenses associated with the malaria cases management combined with other diseases and pregnancy. The direct costs were $20.3 (IQR: 8.9, 39.4) and $19.7 (IQR: 7.0, 29.0) respectively for malaria cases associated with other diseases and pregnancy. At the health facility level, the median direct costs case management of malaria associated with other pathology were $38.5 (IQR: 30.1, 60.9), $36.1 (IQR: 23.2, 59.8), $17.1 (IQR: 1.3, 32.3), $9.4 (IQR: 6.1, 15.3) for the university hospital, district hospitals, private facilities, and health centers, respectively.

Costs associated with the care pathway

In total, 3288 (99.6%) of patients incurred costs throughout their care pathway (care seeking and cases management costs). As for direct non-medical costs, they were incurred by 3080 (93.3%) of patients, while direct medical costs by 3171 (96.1%). For uncomplicated cases, 833 (98.8%) patients incurred a median cost of $7.8 (IQR: 4.4, 16.6). For complicated cases, the direct cost of care pathways was $38.7 (IQR: 18.8, 67.0). Among the pregnant women, all of whom incurred out-of-pocket expenses during the care pathway, the cost was $22.61 (IQR: 7.0, 36.5). By age group, area, and type of malaria, the significant differences between types of direct costs within the same groups were observed (Fig. 3a and b).

Indirect costs (loss of income) associated with malaria

A total of 1573 (47.8%) of respondents reported a loss of income and the median time to seek care of 3 days among 3036 (92.0%) patients. The median income loss associated with malaria exhibited considerable variation across the different forms. They were $13.4 (IQR: 6.7, 26.8) and $13.4 (IQR: 5.4, 26.8) for uncomplicated and complicated forms of malaria. In case of malaria associated with other diseases, the income loss was assessed at
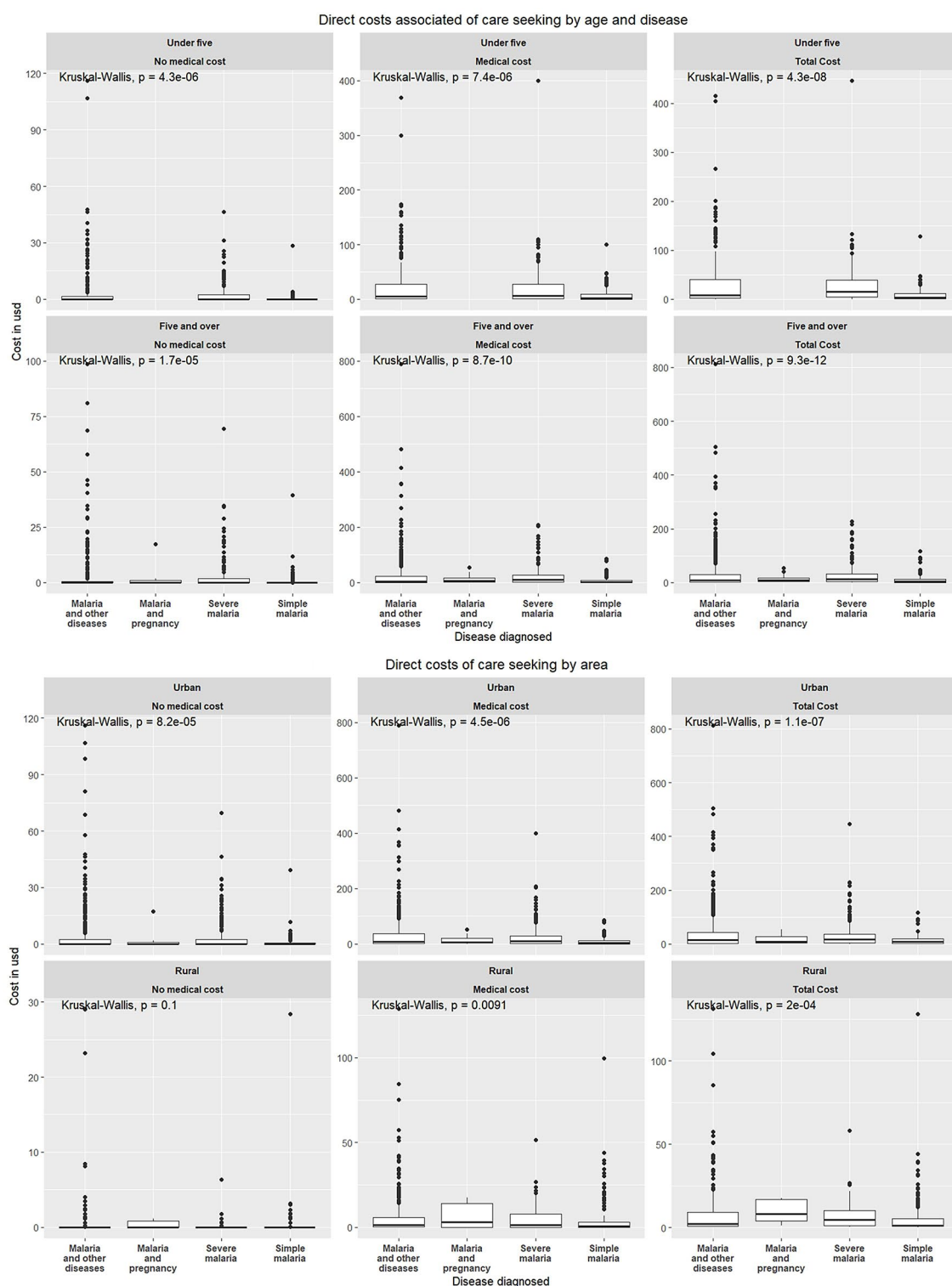
Fig. 2 a Direct cost of care seeking by age. **b** Direct cost of care seeking by area

$15.6 (IQR: 7.1,33.4) and for pregnant women $9.4 (IQR: 5.9, 21.7). For children under five years old, these indirect costs were $12.0 (IQR: 6.7, 26.8), $13.4 (IQR: 5.4, 28.1) for uncomplicated and severe forms. Furthermore, in rural areas, the indirect costs for both forms of malaria were $12.7 (IQR: 5.4, 26.8) and $4.4 (IQR: 2.5 and 10.3) respectively. In rural areas, the most severe forms benefit from

Table 2 Direct costs (usd) associated with malaria case management in survey health facilities

	Simple malaria N = 799[1]	Severe malaria N = 625[1]	Malaria and other diseases N = 1,729[1]	Malaria and pregnancy N = 65[1]	*p*-value[2]
Transportation cost	1.2 (0.7, 1.9)	2.3 (1.2, 5.8)	1.5 (1.2, 3.5)	1.2 (0.9, 2.3)	< 0.001
Other cost	1.2 (0.6, 1.7)	4.1 (1.2, 11.2)	2.3 (1.2, 5.8)	1.2 (1.2, 3.9)	< 0.001
Laboratory cost	3.5 (1.7, 6.4)	5.8 (4.1, 9.9)	5.8 (3.5, 10.4)	5.2 (5.2, 9.3)	< 0.001
Drugs costs	5.2 (2.9, 9.3)	17.4 (9.3, 34.8)	13.9 (5.8, 24.0)	13.3 (5.2, 19.7)	< 0.001
No medical cost	1.7 (1.2, 2.9)	6.3 (2.3, 13.9)	3.5 (1.7, 8.1)	2.3 (1.5, 4.9)	< 0.001
Medical cost	5.2 (2.9, 11.0)	23.8 (13.3, 41.7)	16.8 (7.0, 31.1)	17.4 (6.4, 25.7)	< 0.001
Total direct cost	7.3 (4.1, 13.3)	30.5 (15.7, 51.4)	20.3 (8.9, 39.4)	19.7 (7.0, 29.0)	< 0.001

[1] Median (IQR)

[2] Kruskal-Walli's rank sum tests

pre-referral treatment to district hospital for adequate care, resulting in less wasted time.

Costs associated with malaria, reported and from the patient's perspective

Overall, the median costs (direct and loss of income) of uncomplicated and complicated malaria incurred by patients were estimated at $17.4 (IQR: 6.7, 34.8) and $43.5 (IQR: 19.7, 74.0) respectively. For children under five years old, these costs associated were $15.9 (IQR: 7.3 and 31.5) and $44.1 (IQR: 19.4, 86.0). In the five years old and over group, these costs were $18.0 (IQR: 6.5, 35.8) and $43.4 (IQR: 20.1, 65.4) respectively. In urban settings, the median cost associated with uncomplicated malaria was $22.1 (IQR: 12.0, 42.1) and $50.9 (28.0, 81.2) for complicated cases. The costs were found to be lower in rural areas, with the median costs being $11.3 (IQR: 4.6, 26.3) and $15.7 (IQR: 7.3, 25.7) respectively for uncomplicated and complicated cases of malaria. The duration spent on the care pathway accounted for 18.9% of malaria-related costs ($p < 0.001$).

Discussion

The results of this study on the costs associated with the care pathway of malaria patients in Guinea reveal that the pathway resulted in expenses for nearly 9 out of 10 patients. At the time of the investigation, three-fifths of the individuals had already undergone two or more care pathways. This behavior of seeking multiple and sometimes unconventional care resulted in additional costs, which have been estimated to be as high. During the care-seeking phase, a considerable proportion of the expenditure was related to medical care. Almost all participants reported incurring medical and non-medical expenses, despite the free approach to malaria care in the Republic of Guinea. This situation raises questions about the effective application of this approach in a country where the out-of-pocket cost for most patients is 100%. A return to the principles of primary health care by introducing free care for under five years old (selective free care) and an accessible flat rate for other malaria patients could guarantee the sustainability of revenues for health care facilities while controlling costs for patients or their families.

Studies carried out in endemic countries have shown that malaria patients incur costs either in the health facility or at the level of an unconventional source of care. Our results show that non-conventional pathways (self-medication, traditional therapy) cost about $2 with the possibility of extreme highs. This care-seeking behavior can result in additional costs, as evidenced by the findings of a study carried out in Senegal and Mali [23, 24]. The unregulated self-diagnostic capability of disease, beliefs, and cultural habits increases out-of-pocket expenses and leads to a delay in appropriate care. Adapting the malaria care service offering to the patients' care-seeking behavior would, on the one hand, improve early care and, on the other hand, reduce out-of-pocket expenses. This approach would involve, for example, the integration of some traditional healers into the community continuum and the implementation of RDTs at the pharmacy level for clients suspected of malaria.

As some elements of this study show, free malaria care (ACT and derivatives, RDTs) in health facilities has not been achieved, with out-of-pocket costs of about $8 and $31 for simple and severe forms in nearly all patients. This observation can be explained on the one hand by the absence of health insurance covering the costs related to care (additional laboratory tests and adjuvant treatments). On the other hand, the costs of receiving services from health practitioners affect 2 out of 5 patients. This situation is not specific to Guinea, however, with lower proportions of patients with out-of-pocket expenses. Patient-level costs for the management of single episodes vary by country and setting: $6.8, including $15.5 in urban Uganda, $4.9 [0.13–46.7] in Ghana and $2.98 in rural Senegal [8, 23, 25].

The costs associated with severe malaria were higher due to additional laboratory tests, hospitalization, and adjuvant treatment for the management of complications that are not included in the free approach. A 2016 study
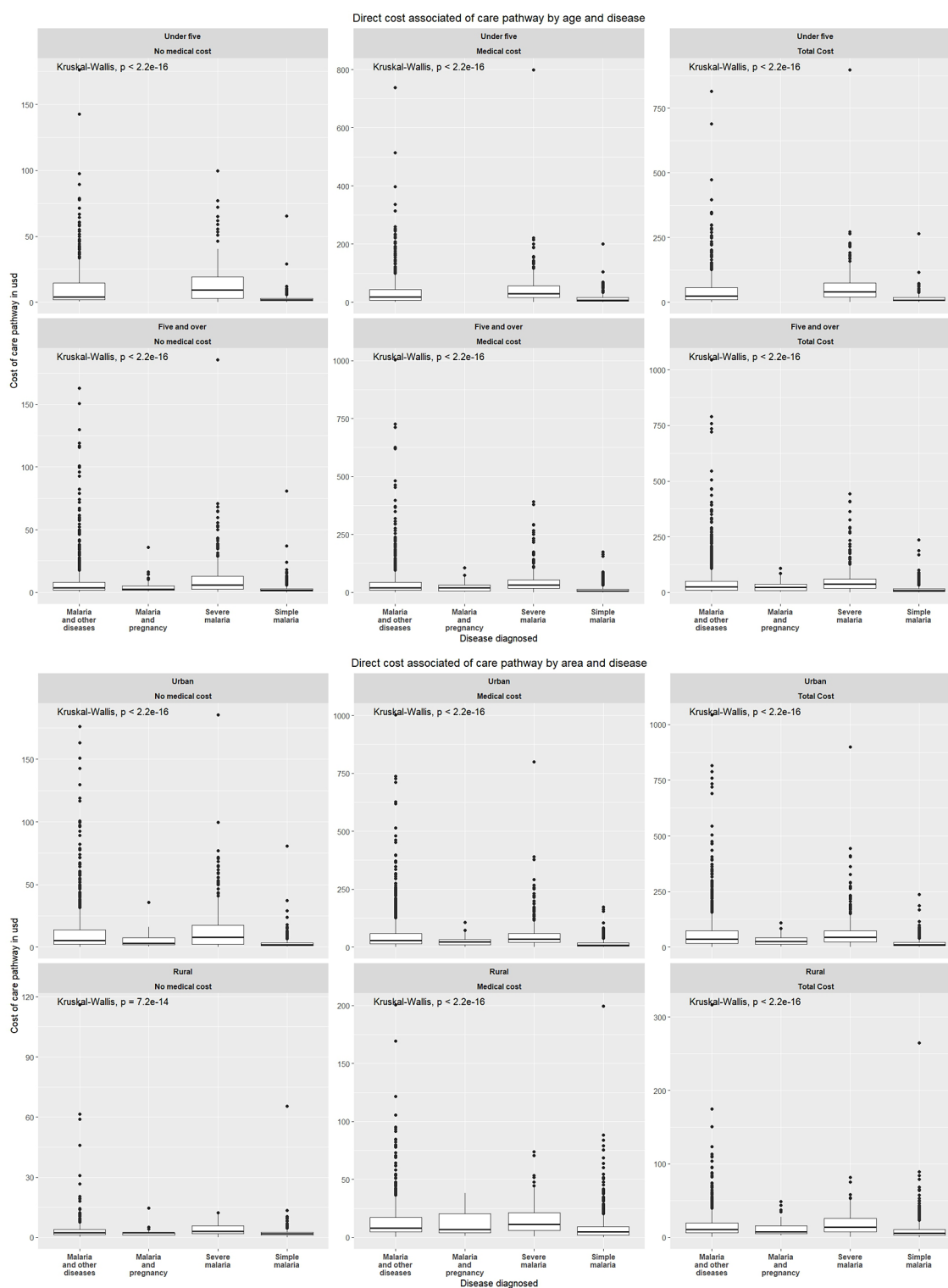
Fig. 3 **a** Cost of care pathway by age and_disease. **b** Cost of care pathway by area and disease

conducted in Burkina Faso revealed a significant difference in cost between simple and severe malaria [7].

The results indicated that the costs associated with these two forms of malaria from the patient's perspective vary significantly, with estimates of $17.4 and $43.5 respectively. This difference underscores the importance of early and appropriate case management. Children under 5 years old, who constitute a vulnerable group,

bear high costs for both uncomplicated and complicated forms of the disease. This situation in poor households increases the vulnerability of young children to malaria and highlights the need to reorient free malaria care towards this group. Furthermore, the differences in costs between urban and rural areas are significant, with higher median costs observed in urban areas. This disparity may be due attributed to several factors, including the availability of more extensive technical platforms in urban areas, the shapes treated and economic differences. This analysis of direct and indirect costs from the patient's perspective highlights the time spent seeking care as an important contributing factor to the costs associated with malaria. These data highlight the impact of time spent seeking care on direct costs and underline the need to improve timely access to healthcare services to reduce these costs. Similar trends observed in Burkina Faso, with an estimated cost of $27.1 [7]. In the Democratic Republic of Congo, with the perspective of the National Malaria Control Program, the average cost associated with episodes of simple malaria was estimated at $36.3, with $16.7 for direct costs and $19.6 for indirect costs [26]. In Peru (Latin America), the total average cost associated with the episode of simple malaria was estimated at $161 with a patient burden of $131 [27]. Differences between rural and urban areas are also reported with slight differences [28]. The various results show the need to mobilize domestic resources to finance health insurance systems and free health care systems for vulnerable groups (children and pregnant women). These approaches have already showed satisfactory results in Ghana and Burkina Faso [29, 30].

This study provides detailed information on the costs of the care pathway for malaria patients in the Republic of Guinea from the patient's perspective. This approach made it possible to comprehensively analyze the costs incurred by the patient for a disease whose management approach is centered on free treatment.

The limitations of our approach mainly include the lack of evaluation of costs from the perspective of healthcare service providers, the National Malaria Control Program (NMCP), and the costs incurred by other patients who have not used healthcare facilities and community health workers.

Conclusion

The results of this study illuminate the significant costs associated with the diagnostic and treatment pathways of malaria patients in Guinea. Despite being free, a majority have incurred expenses during their care pathway, with a significant proportion opting for non-conventional care as their first choice, resulting in additional costs. Patients have shouldered medical and non-medical costs, raising questions about the ability to ensure complete free-of-charge care from the patients' perspective. This underscores the importance of reevaluating the free approach and redirecting services towards accessible flat-rate costs to ensure the financial sustainability of health facilities while minimizing the costs borne by patients. Additionally, it is crucial to consider care-seeking behaviors and adapt the provision of malaria management services to improve the timeliness of care and reduce out-of-pocket expenses. Finally, mobilizing domestic resources to finance health insurance systems and free healthcare schemes for vulnerable groups, such as children and pregnant women, is essential to ensure access to care and reduce out-of-pocket expenses. The next steps of this research project will focus on the impact of free selective and flat-rate pricing on reported income and the analysis of the perception of malaria prevention services by practitioners and users.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Author contributions
Elhadj Marouf Diallo is the main and corresponding author of this article, written under the co-supervision of Professor Alioune CAMARA and Professor Laurent GERBAUD. Co-author MB supported to develop the analysis plan and structure of different costs.The co-authors (FBT, AL, BSC and SS) contributed to reviewing the analyses, formatting the tables and proofreading the manuscript. Specially co-authors FBT and BSC supported the English translation of the paper and the proof-reading of the translation. All co-authors read and approve final manuscript before submitting. Letitia A ONYANGO supported the revision of the English version of the manuscript during the first revision round.

Data availability
No datasets were generated or analysed during the current study.

Materials availability
In Additional file

Code availability
Analysis code R is available on request

Declarations

Ethics approval and consent to participate
The study was approved by the National Ethics Committee for Health Research of Guinea (reference number #151/CNERS, 2022). This study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent is obtained from each patient or caregiver prior to data collection.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]African Centre of Excellence for the Prevention and Control of Communicable Diseases, Faculty of Health Sciences and Techniques, University of Conakry, Conakry, Guinea
[2]CHU Clermont-Ferrand, UFR Medicine & Paramedical Professions, University Clermont Auvergne, CNRS, Sigma Clermont, Pascal Institute, Aubière, France
[3]Department of Preventive Medicine, Institute for Global Health, Northwestern University, Chicago, USA
[4]Centre National de Recherche et de Formation en Santé Rurale (CNRFSR), Maferenyah, Forecariah, Guinea
[5]National Malaria Control Program (NMCP), Conakry, Guinea

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