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Costs and Evolution of Malaria Care in Kisangani, Tshopo Province, The Democratic Republic of Congo from 2020 to 2023

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ABSTRACT

The fight against malaria has reached a worrying stagnation in achieving the objectives of the WHO Global Technical Strategy (2016-2030), amid particularly marked underfunding in the DRC. In Kisangani, the equatorial climate and the lack of sanitation contribute to intense and continuous transmission of malaria, which means that the cost of the disease places a heavy burden on households. This study aims to analyze the cost and trends in malaria-related medical care in Kisangani hospitals in order to assess the economic impact of malaria on health care systems. To this end, it adopts a retrospective descriptive approach with analytical aims, focusing on 2,968 patients. The data were analyzed using SPSS v27 software (means, medians, standard deviations, ANOVA, and Tukey). The results show that the affected subjects have a mean age of 27 years, with a predominance of adults (65.9%) and students (47.9%). The general referral hospitals of Mangobo (38.5%) and Tshopo (27.6%) recorded the highest number of cases. The average cost of care was 64,075 CDF, primarily due to medication (43,701 CDF, or 68%). Significant differences were observed between hospitals. The annual trend in the number of cases was irregular, peaking in 2021 (917 cases), followed by a decrease until 2023 (687 cases). Therefore, there is a significant difference in the cost of care between the years covered by the study. The differences in average costs between years were not due to chance ($F = 51.905$; $p < 0.001$). These results demonstrate how malaria represents a significant and direct economic burden for households in Kisangani, particularly due to the cost of medication.

Keywords: Costs, Evolution, Malaria, Care, Kisangani

1. INTRODUCTION

Malaria is a very common disease that affects children under 5 years old in developing countries in general and in the Democratic Republic of the Congo in particular. Global statistical show each year that many people are reported to be affected. Pregnant women, children under five, and people living in precarious

socioeconomic conditions are the groups most affected by malaria. Malaria is the principle cause of hospitalization, its places a heavy economic burden on households and health care systems in poor countries due to the high costs associated with medical consultations, diagnosis, and treatment (Aubry & Gaüzère, 2019; WHO, 2024).

According to Bouyssou & Menard (2023), each year malaria remains a serious disease, affecting hundreds of millions of people and causing deaths. For several decades, it has been reported that many people are exposed to this endemic disease and the statistical raise each year (Hanitriniaina, 2017 ; Sanogo, 2021). Sub-Saharan Africa is the part of the continent where the epidemiology varies considerably from one region to another and gives constant cases of malaria (Nkumama et al, 2017), bears a significant share of this public health crisis, accounting for a high proportion of deaths in the world (WHO, 2020; WHO, 2023).

The Democratic Republic of Congo (DRC) is one of the second countries second after Nigeria with many cases of malaria, in particular children under five (Kanga, 2021; WHO, 2024). Losimba et al., (2018) note that malaria is the leading endemic disease and the primary cause of outpatient visits in the city of Kisangani and mortality, where the most vulnerable groups reported remain pregnant women and children under five. Various reports provided by health establishments report that children under five account for more than half of malaria-related deaths, highlighting the importance of strengthening targeted interventions for this group to reduce the infant mortality rate, malaria always occupies first place (WHO, 2024).

The equatorial climate characterizing the Tshopo Province constitutes the main factor favoring the transmission of malaria, add to this lack of environmental hygiene. The report published by the Ministry of Planning and the Ministry of Public Health of the DRC in 2014 confirms this situation. According to this report, several cases of death of children under five years of âge are caused by malaria, wich remains the main reason for consultation, dispite multiple advances tha hihglight the vaccine against thi endemic pathology (Ministry of Planning and Ministry of Public Health of the DRC, 2014; WHO, 2022). Furthermore, the persistence of this pathology is favored by the multiplication of Anopheles mosquitoes, vectors of malaria associated with climatic factors characterized by high temperatures. Non-observence of environmental hygiene and public health rules is also associeted with the resurgence of malaria in African countries (Diouf et al., 2020).

The relevance of this study, which specifically covers the period from 2020 to 2023, stems from a dual crisis: a biological crisis and a financial crisis. On the one hand, the effectiveness of care protocols and control strategies is threatened by structural barriers such as poverty, insufficient health coverage, vector resistance to insecticides (Li et al, 2024), as well as the emergence of genetic mutations of the parasite on the Kelch13 gene, which jeopardize the effectiveness of artemisinin-based therapeutic combinations (Gashema et al, 2025). The initiation ot the vaccine against malaria may seem an ideal prophylactic means, but the change in mentalities in the strict observance of the general hygiene measures and the promotion of health systems contribute to the reduction of this disease (Olawade et al, 2024).

Another problem that deserves to be analyzed is the inacessibility to primary health care which characterizes many households with limited revenue. Therefore, financing health services is essential to limit the development of malaria (WHO, 2023). Consequently, the economic cost of this epidemiological pressure is directly transferred to the budget of health structures and households in Kisangani. The direct costs of malaria weigh heavily on the budgets of low-income families, while social precarity and inadequate diagnoses worsen local morbidity (Oyegoke et al, 2022; Eneh et al, 2024).

Malaria remains a major cause of consultations and hospitalizations in Kisangani, the capital city of the Tshopo Province. Most healthcare costs are paid directly by patients and their families, whose incomes are generally low and limited. This financial burden restricts access to medical care, driving people toward self-medication and resulting in more severe complications.

Over the period from 2020 to 2023, malaria case management in Kisangani was presumably influenced by a combination of factors, including volatile drug pricing, stock outs of rapid diagnostic tests, differing clinical practices among providers, and patients' low financial capacity. Analyzing this evolution is crucial to understanding cost dynamics and barriers to care. It also provides useful data for health policymakers, facility managers, and technical and financial partners working to combat malaria.

This study is set within this context, aiming to analyze the costs and measure the evolution of medical care for malaria in Kisangani during this period. It seeks to show the structure of healthcare costs, compare their evolution over time, and assess their impact on access to care. The expected findings will help better understand the economic burden of malaria and guide health interventions to reduce the financial strain on the population.

The general objective of this study is to analyze the sociodemographic characteristics and the financial burden of managing malaria cases recorded in healthcare facilities in the city of Kisangani.

Specifically, the objectives are to: (1) determine the sociodemographic characteristics of individuals affected by malaria in the studied healthcare facilities; (2) analyze the time trends of the number of malaria cases managed during the period from 2020 to 2023

and (3) assess the direct financial cost of malaria management (consultation fees, laboratory tests, and medication) borne by households in the city of Kisangani.

2. METHODOLOGY

To be able to demonstrate the cost of economic management and its evolution for malaria, a serious methodological approach must be applied; one that allows us to answer the various questions asked and achieve the objectives of this study. Therefore, in the following section, we present the main components of the approach adopted to achieve the expected results.

2.1. Study Framework

This research was conducted in Kisangani, the capital of Tshopo Province in the Democratic Republic of the Congo, from 2020 to 2023. The investigation took place in four reference health facilities and a well-known hospital in the city, including the Cinquantenaire Hospital, which together form a good sample of hospitals providing healthcare in the city, selected for their geographical representativeness and activity volume:

- The Cinquantenaire Hospital: it's a modern healthcare facility that offers specific technical care;
- The Lubunga General Referral Hospital (GRH): it's a healthcare facility located on the left bank of the Congo River, it serves the population on the other, mostly suburban side of the city;
- The Makiso General Referral Hospital: it's a healthcare facility located in the central commune of Makiso;
- The Mangobo General Referral Hospital: it's a healthcare facility found in a densely populated commune;
- The Tshopo General Referral Hospital: it's a healthcare facility covering the Tshopo commune and the Lubuya-Bera Sector, in the northern part of the Kisangani.

Public and public-interest health facilities in Kisangani are the primary referral centers for the management of malaria cases requiring institutional care.

2.2. Type of the Study

To achieve our purpose, we used the descriptive approach to retrospective and analytical targeted over a period from 2020 to 2023.

2.3. Study Population

The study population consisted of all patients living in the city of Kisangani, the new housing developments, or the peri-urban area of Kisangani, who were officially admitted and treated for malaria in the five aforementioned hospital facilities.

2.4. Sampling

A simple random probabilistic sampling technique was used for this study, from a total of 2,968 malaria cases recorded in the 5 facilities healthcare under study.

- Inclusion criteria: included in this study were all malaria cases (uncomplicated or severe) that were recorded, diagnosed and treated in the selected hospitals, and whose medical records contained usable financial data (medical billing forms, cash receipts, or pharmacy, consultation, and laboratory invoices).
- Exclusion criteria: Patients whose malaria diagnosis was not formally confirmed by the clinician, any patient whose admission date fell outside the 2020–2023 timeframe and all incomplete clinical or financial records were excluded.

2.5. Data Collection

To collect the data, we used the documentary technique. It allowed us to extract information recorded in hospital archives (patient registers, clinical files, and billing records). For each eligible patient, the data were compiled taking into account the admission date and the variables of interest.

The study focuses mainly on direct costs charged to patients (consultation fees, lab tests, and medications), in line with the constraints of hospital retrospective analysis.

2.6. Operational Definition of Variables

For this study, we have two types of variables :

- dependent variable is the direct cost of malaria-related care,
- independent variables are time (2020-2023), type of health facility, and sociodemographic characteristics.

2.7. Data Analysis

The data were typed and coded in Microsoft Excel before being exported to SPSS version 27.0 for analysis. On the descriptive side, we calculated frequencies and percentages for categorical variables. For costs and age, we calculated arithmetic averages, medians, quartiles, and percentiles to measure the symmetry of the financial distribution.

To test the significance of cost differences between health facilities and according to yearly trends, we conducted one-way ANOVA. Several pairwise comparisons were performed using Tukey's post hoc test. The significance threshold used was 0.05.

2.8. Ethical Considerations

To ensure patient anonymity, each record was assigned a unique numerical code; no personal data was used. The data were collected after receiving administrative approvals from the medical directors and the secretariats of the health zones and hospitals involved in the study.

3. RESULTS

In this section, we present the results obtained from the analyses. We first describe the sociodemographic characteristics of the participants, and then present the results regarding the cost of care and its impact.

3.1. Socio-demographic characteristics of the subjects

As noted in the Methods section, two sociodemographic variables were considered in this study –age and sex– and the results are presented in the tables below.

Table 1. Descriptive statistics of subjects' age

Average	Median	Standard Deviation	Range	Minimum	Maximum
27.65	25	15.44	89.9	0.1	90

The descriptive statistics for age mentioned in Table 1, show a relatively young population, with an average age of 27.65 years and a median of 25 years. The standard deviation (15.44 years) and the wide age range (1 to 90 years) indicate substantial variability in the sample. When grouped into age brackets, the distribution is as follows:

Table 2. Distribution of subjects by age groups

Age groups	N	%
Under 1 year	746	25.1
1 to 5 years	1,955	65.9
6 to 18 years	105	3.5
19 to 59 years	152	5.1
60 years and over	10	0.4
Total	**2,968**	**100**

Table 3. Distribution of subjects by gender

Gender	N	%
Male	1,402	47.2
Female	1,566	52.8
Total	**2,968**	**100**

The age-group distribution presented in Table 2 shows that malaria primarily affects children aged 1 to 5 years, accounting for 1,955 cases (65.9%), followed by those under one year of age with 746 cases (25.1%). The number of recorded cases decreases as age increases.

Regarding the distribution by gender in Table 3, there is a slight predominance of female subjects, who make up 52.8% (n=1566) of the sample, compared to 47.2% (n=1402) for males. The sex ratio is 0.89.

Table 4. Distribution of subjects by health facility

Health structure	N	%
Cinquantenaire Hospital	249	8.4
GRH Lubunga	370	12.5
GRH Makiso	385	13.0
GRH Mangobo	1,143	38.5
GRH Tshopo	821	27.6
Total	**2,968**	**100**

An analysis of Table 4 reveals a total of 2,968 malaria cases recorded across the five targeted hospitals in Kisangani. We observed a significant concentration of cases at the Mangobo General Referral Hospital (1,143 cases, or 38.5%) and the Tshopo General Referral Hospital (821 cases, or 27.6%). Conversely, the Cinquantenaire Hospital recorded the lowest proportion of cases, with 249 (8.4%). The graph below shows the annual distribution of the 2,968 malaria cases recorded at five health facilities in Kisangani from 2020 to 2023.

3.2. Temporal evolution of malaria cases (2020-2023)

Over time, the evolution in the number of cases in the hospitals studied is presented as follows:

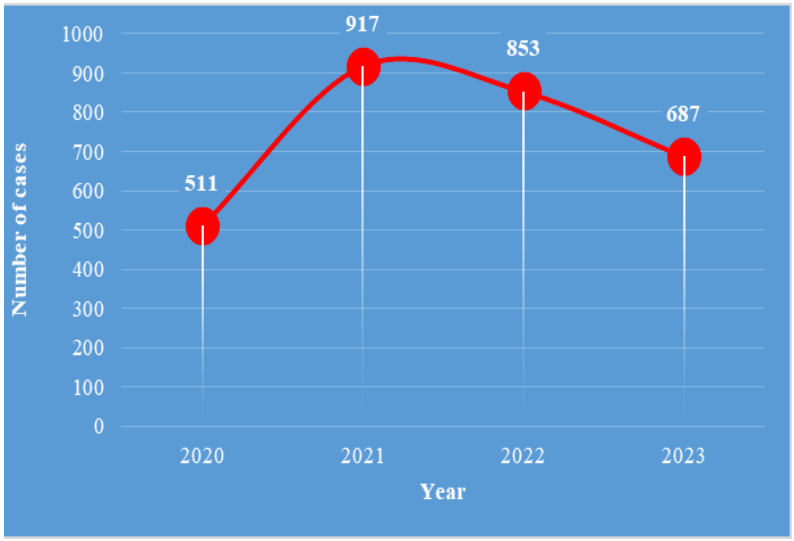


Figure 1. Temporal evolution of malaria cases from 2020 to 2023.

Figure 1 shows an oscillatory (saw-tooth) pattern in malaria cases at the hospitals under study in Kisangani throughout the study period. The number of cases was low in 2020 (511 cases, or 17.2%) before peaking in 2021 at 917 cases (30.8%), the most critical year of the period studied. This trend subsequently reversed, with a steady decline in 2022 (853 cases, or 28.7%), followed by a further drop in 2023 to 687 cases (23.1%).

Considering the healthcare facilities, this evolution is as follows:

Table 5. Evolution of malaria cases by healthcare facility per year

Healthcare Structures	2020	2021	2022	2023	Total	
					n	%
GRH Makiso	89	69	109	118	**385**	**13,0**
Cinquantenaire Hospital	39	51	86	73	**249**	**8,4**
GRH Tshopo	114	303	153	251	**821**	**27.7**
GRH Mangobo	180	414	411	138	**1,143**	**38.5**
GRH Lubunga	89	80	94	107	**370**	**12.5**
Total	**511**	**917**	**853**	**687**	**2,968**	**100**
% Annual	**17.2**	**30.9**	**28.7**	**23.2**	**100**	

Table 5 shows that Mangobo GRH has the highest number of malaria cases (1,143), or 38.5%, followed by Tshopo GRH with 821 cases, or 27.7%. On the other hand, the Cinquantenaire Hospital has the lowest case frequency (249), or 8.4%. This breakdown of malaria cases does not follow a stable trend. Admissions were also high, with 30.9% in 2021 and 28.7% in 2022, at Mangobo GRH and Tshopo GRH, respectively; they then started to decline, falling to 23.2% in 2023.

3.3. Evolution of the costs of Malaria care

3.3.1. Overall Descriptive Analysis and Costs Structure

The following table shows the direct healthcare costs for malaria treatment, divided by cost category (medicines, laboratory diagnostics, physician visits), and reviews the statistical measures.

Table 6. Overall Descriptive Statistics of Malaria Care Costs

Hold Care post	Average ± ET (CDF)	Median (CDF)	IC95 % of Average	Min	Max
Medication	43,700.8 ± 29,462.7	38,000	42,640.4 – 44,761.2	2,000	721,000
Laboratory	11,339.6 ± 9,144.6	10,000	11,010.5 – 11,668.8	0	150,000
Consultation	9,034.7 ± 6,214.7	9,000	8,811.0 – 9,258.4	0	28,000
Total	**64,075.1 ± 32,999.7**	**58,800**	**62,887.4 – 65,262.8**	**10,000**	**734,000**

In Table 6, the descriptive analysis of the costs of malaria care shows an average total expenditure of 64,075.13 CDF and a median of 58,800 CDF. The observed costs of malaria care in Kisangani show considerable variability, as evidenced by a high standard deviation of 32,999.67 CDF and a wide range from 10,000 CDF to 734,000 CDF. Medicines are the main expense, with an average cost of 43,700.81 CDF, accounting for about 68% of the total care costs. This category also shows the highest cost variability, with extreme values reaching 721,000 CDF. Laboratory and consultation fees are lower, with average costs of 11,339.62 CDF and 9,034.70 CDF, respectively.

3.3.2. Analysis of the distribution of malaria treatment costs by percentiles and Tukey's hinge values

Using percentiles and Tukey's indicators allows us to partition the sample in order to observe trends in health care spending, and measure the interquartile range (IQR), which is less affected by outliers.

Table 7. Percentile distribution of malaria treatment costs in the studied healthcare facilities

Hold care post	P5	P10	P25 (Q1)	P50 (Median)	P75 (Q3)	P90	P95
Medication	15,000	20,000	28,000	38,000	51,000	78,000	78,000
Laboratory	0	2,000	5,000	10,000	15,000	20,000	25,000
Consultation	5,000	5,000	5,000	9,000	10,000	10,000	28,000
Total prise en charge	27,612.5	34,000	43,625	58,800	78,000	105,000	115,550

If we split the patients into several groups, the results show in Table 7 that the bills paid by patients vary a lot from one person to another. About half of them spend between 43,625 CDF and 78,000 CDF on treatment, with a midpoint of 58,800 CDF. However, costs become extremely high for the most severely ill patients: the 25% of patients whose care was most expensive paid more than 78,000 CDF, and for the most complex cases (the top 5% in terms of cost), the bill exceeded 125,550 CDF.

When we look closely, we realize that medicines are what weigh most heavily on family budgets. They represent the biggest and least stable expense, with half of patients paying between 28,000 CDF and 51,000 CDF just for pharmacy costs. On top of that, other hospital services are much cheaper and vary little from place to place. Lab tests remain affordable, usually costing around 10,000 CDF, while consultation fees are the most stable, with the vast majority of hospitals charging between 5,000 CDF and 10,000 CDF.

3.3.3. Analysis of Total Cost by Hospital

This table below shows the breakdown of the total amount of medical bills paid by patients across hospitals.

Table 8. Total cost of care by healthcare facility (in CDF)

Hospitals	n	Average	Standard Deviation	Min	Max
GRH Tshopo	821	55,795.25	40,468.42	17,500	734,000
GRH Mangobo	1,143	58,671.70	27,306.88	10,000	375,000
GRH Lubunga	370	71,339.46	27,182.93	15,750	221,200
GRH Makiso	385	72,199.87	25,549.95	15,750	105,000
Cinquantenaire Hospital	249	92,822.49	26,399.08	33,750	123,000
Total	**2,968**	**64,075.13**	**32,999.67**	**10,000**	**734,000**

Table 8 shows that malaria treatment is most expensive at the Cinquantenaire Hospital, where the average medical bill amounts to 92,822.49 CDF, followed by the Makiso and Lubunga General Referral Hospital (GRH), where average costs are 72,199.87 CDF and 71,339.46 CDF, respectively. In contrast, the most affordable average healthcare costs among the health facilities studied are found at the GRH Tshopo (55,795.25 CDF) and at the GRH Mangobo (58,671.70 CDF). Even though the GRH Tshopo has the lowest overall average, it's actually in this hospital that the highest bill in the entire study was recorded, hitting an exceptional amount of 734,000 CDF. The significant variation in expenditures, confirmed by a high standard deviation of 40,468.42 CDF, indicates that this hospital treats severe or complex cases of malaria. To assess whether these disparities in rates among hospitals are due to chance, an analysis of variance (ANOVA) was conducted. The table below presents the results.

Table 9. Comparisons of care costs by Healthcare facility

Source of change	Sum of squares	ddl	Average square	F	p-value
Between groups	340,372,821,123.394	4	85,093,205,280.849	87.224	<0.001
Intra-groups	2,890,625,753,822.698	2, 963	975,573,997.240		
Total	**3,230,998,574,946.092**	**2, 967**			

The results in the Table 9 confirm that the difference in healthcare costs across healthcare facilities ($F = 87.224$; $p < 0.001$) is statistically significant. To precisely identify which hospitals stand out from each other, the Tukey Multiple Comparison Test classified the five facilities into three distinct and homogeneous subgroups as follows:

Table 10. Multiple comparison of average malaria management costs by health facility (Tukey test)

Healthcare facility	n	Subset 1	Subset 2	Subset 3
GRH Tshopo	821	55,795.25		
GRH Mangobo	1,143	58,671.70		
GRH Lubunga	370		71,339.46	
GRH Makiso	385		72,199.87	
Cinquantenaire Hospital	249			92,822.49
Significance		**0.651**	**0.994**	**1.000**

Table 10 shows that the first group highlights the Tshopo and Mangobo General Referral Hospital, which offer the lowest healthcare rates, and have average costs that are statistically equivalent. The second group includes the GRH Lubunga and the GRH Makiso, which show higher prices but are comparable to each other. Finally, the Cinquantenaire Hospital stands out clearly from the other healthcare facilities, forming a third group, which confirms that the average cost of healthcare is significantly higher than that recorded at the other healthcare facilities studied.

3.3.4. Analysis of care costs per year

The following table shows the trend in total healthcare costs of malaria paid by patients during the period covered by this study.

Table 11. Annual evolution of total care costs (in CDF)

Year	n	Averages	Standard Deviation (Spread)	Min	Max
2020	511	77,452.64	32,748.75	14,000	190,000
2021	917	55,433.37	26,015.68	10,000	307,000
2022	853	65,328.49	32,108.85	15,750	375,000
2023	687	64,103.49	38,643.31	15,750	734,000
Total	**2968**	**64,075.13**	**32,999.67**	**10,000**	**734,000**

The data in Table 11 shows that patient expenses don't follow a regular pattern. We observed that the average cost of malaria care was relatively high, peaking at 77,452.64 CDF in 2020. Costs in other years were significantly lower. In 2021, a statistically significant decline in malaria-related treatment costs was observed, with the mean expenditure reaching its lowest point at 55,433.37 CDF. In order to verify that these annual fluctuations in medical expenditures were substantial and non-random, a second one-way analysis of variance (ANOVA) was performed.

Table 12. Comparisons of care costs according to the years considered

Source of change	Sum of squares	ddl	Square average	F	p-value
Between groups	161,269,562,760.109	3	53,756,520,920.036	51.905	<0.001
Intra-groups	3,069,729,012,185.981	2,964	1,035,671,056.743		
Total	3,230,998,574,946.091	2,967			

The test statistically in Table 12 confirms that the differences in average costs between the years are not due to chance ($F = 51.905$; $p < 0.001$), indicating a significant difference in the cost of care between the years covered by the study. Multiple comparisons using Tukey's test allow the years to be grouped into three distinct spending periods.

Table 13. Homogeneous subsets of average costs by year (Tukey)

Year	n	Subset 1	Subset 2	Subset 3
2020	511			77, 452.64
2021	917	55, 433.37		
2022	853		65, 328.49	
2023	687		64, 103.49	
Significance		**1.000**	**0.891**	**1.000**

Table 13 shows that the lowest healthcare costs of the entire period studied are observed in 2020. Regarding the period between 2022 and 2023, the result confirms that there is no statistically significant difference ($p = 0.891$), which reflects the stability observed in billing practices during this period. Furthermore, we noted that healthcare costs were significantly lower in 2020 ($p < 0.001$).

The table 14 compares the years, two by two, to measure exactly how much the bills have increased or decreased and to check if these changes are significant. First, the numbers show that 2020 was exceptionally expensive year. After adjusting for cost variations, we found that patients paid an average of 22,019.00 CDF more in 2021, 12,124.00 CDF more in 2022, and 13,349.00 CDF more in 2023. All that differences are confirmed by a p-value of less than 0.001, which indeed shows an increase in healthcare costs after 2020.

Table 14. Multiple comparisons of the average costs of malaria care by year (Tukey Test)

Year (I)	Year (J)	Difference Average	Standard Error	p-value	IC to 95%
2020	2021	22,019.27	1,776.56	<0.001	17,452.64 – 26,585.90
	2022	12,124.15	1,800.25	<0.001	7,496.63 – 16,751.68
	2023	13,349.15	1,879.97	<0.001	8,516.71 – 18,181.59
2021	2022	-9,895.12	1,530.87	<0.001	-13,830.20 – -5,960.03
	2023	-8,670.12	1,623.87	<0.001	-12,844.25 – -4,495.99
2022	2023	1,224.99	1,649.75	0.880	-3,015.67 – 5,465.66

Conversely, 2021 stands out as the cheapest period in the study. The negative results in the table show that in 2021, the average bill was 9,895 CDF lower than in 2022 and 8,670 CDF lower than in 2023, two decreases those are also both significant. It should be noted that a comparison of treatment costs recorded between 2022 and 2023 yields a different result, with the difference being only 1,224 CDF and the p-value being very high (0.880). This means that the small difference observed between these two years is not statistically significant, indicating that malaria treatment costs have stabilized in Kisangani during this recent period.

4. DISCUSSION

We have observed in this series that women are mostly represented (52.8%) of malaria cases compared to 47.2% of men in Kisangani during the study period. Female predominance could be explained by their involvement in domestic and economic activities, which expose them more to mosquito bites. It should also be noted that in our study environment, there are more women than men. What can justify their ascendancy over men. This female predominance confirms the results of the DRC Demographic and Health Survey (DHS-DRC) published by the Ministries of Planning and Public Health in 2014, and the WHO World Malaria Report (WHO, 2023; WHO, 2025), which highlight the influence of gender on risk exposure and access to health care. These various surveys report that the number of women is increasing sharply compared to men. However, a male predominance in certain provinces of the DRC, likely linked to nighttime agricultural and forestry activities which expose them to the risk of malaria. This variability of the result confirms that malaria epidemiology depends on the environmental, behavioral, and socioeconomic context across different regions of the world (WHO, 2022).

The results of our survey also show that children aged 1 to 5 years were most affected by malaria (65.9%). This distribution highlights the health and economic impact of malaria on the working population, due to the loss of productivity and healthcare expenditures it generates. This means that economic activity decreases significantly when a population has a high morbidity rate. This result is contrary to multiple observations which report the resurgence of malaria in children under five years old. This is consistent with the observation made in Ghana by Asante et al. (2021) who make the same observation in their series with a high rate of children affected by malaria, but differ from the national statistics reported in 2011 by the DRC's National Malaria Control Program (2011), according to which children under five account for the majority of severe cases and deaths due to malaria because they, along with pregnant women, constitute a group vulnerable to malaria. This difference is likely due to the fact that our sample consists primarily of hospitalized patients. Furthermore, Nkumama et al. (2017) emphasized in their series that malaria distribution varies depending on the climatic context, the time period under consideration, gender, and occupational background. The determinants of malaria resurgence are variable.

The trend depending on the length of this study shows a decrease in cases of malaria in 2020, followed by an increase in 2021 and 2022, and then a slight decrease in 2023. This trend could be explained by several factors, notably healthcare service disruptions related to the COVID-19 pandemic, climatic conditions favorable to the proliferation of mosquitoes—the disease vectors—and inadequate environmental sanitation services throughout the city. An observation made across the city of Kisangani sufficiently shows the increasing unsanitary conditions both in public places and in residential areas. This encourages the multiplication of mosquitoes, which causes the persistence of malaria in our environment. The high cost of malaria treatment could be worsened by indirect costs such as transport, food during hospitalization and loss of income, combined with a weak health system characterized by few rural facilities, insufficient staff and additional (Maketa et al., 2022; Diouf et al, 2020). Indeed, climatic factors play a decisive role in transmission dynamics by influencing both the proliferation of the mosquito vector (*Anopheles* spp.) and that of the parasite (*Plasmodium* spp.). The main parameters involved are temperature, precipitation, relative humidity, and, to a lesser extent, wind which characterizes the equatorial climate, favorable to malaria (Savi, 2022).

The breakdown of malaria cases among the health facilities in this study shows a high rate of cases at the Mangobo and Tshopo General Referral Hospitals. In these areas, environmental hygiene is not practiced by the residents and access to safe water is limited. Meanwhile, the Cinquantenaire Hospital has the lowest percentage, because it is located right downtown where hygienic conditions are almost perfect. This situation is probably linked to observed differences in environmental exposure, population density, and access to healthcare – all of which are major determinants of malaria transmission and control. The climate and insanitary conditions of the environment favor the proliferation of mosquito's bites, the speed with which people seek care, and the effectiveness of preventive measures (Caminade et al, 2014). In Kisangani, there are unsanitary neighborhoods where access to clean water and healthcare remains limited due to the low incomes that characterize most households. Demographic factors are not excluded from this situation, which fosters the exponential transmission of malaria. It should be noted that in environments where housing is crowded, the risk of contracting malaria is high than where the population density is low (Losimba et al, 2018). Conversely, the higher cost of healthcare observed at the Cinquantenaire Hospital could significantly limit accessibility to healthcare services. This drives vulnerable, low-income households to visit less-equipped health centers where medical bills are affordable; others even prefer to resort to the practice of self-medication, despite all the risks of disease complications.

In our study, the average cost of a malaria episode was 64,075.13 CDF, of which nearly two-thirds (65.59%) was spent by patients on purchasing medications. In Kisangani, the cost of medicines represents the heaviest and most direct financial burden for households dealing with malaria. Given that episodes of malaria are recurrent, expenditure on treatment increases further, which reduces limited household incomes and consequently, access to care remains limited. In the Democratic Republic of Congo, the government's universal health coverage program is still being deployed, and the financing of care relies predominantly on direct payments by families at the time of illness. In our country, there is no health insurance to be able to alleviate the burden of malaria which permanently burdens families. The direct costs linked to malaria borne by poor households observed in health facilities reflect the absence of an effective health policy in the fight against this disease which remains endemic. A review of the literature highlights a major socioeconomic and geographic fracture between urban and rural households when facing the financial burden of medicine costs. In urban centers, although families are sometimes subjected to higher care tariffs—as illustrated by the cost structure of the Cinquantenaire Hospital—they benefit from a denser network of retail pharmacies, a wider diversity of healthcare offerings, and occasionally, more stable monetary incomes that help absorb the immediate financial shock of a medical prescription.

Conversely, in rural or isolated peri-urban areas (such as the situation observed on the left bank at the Lubunga General Referral Hospital), the cost of medicines turns into a virtually insurmountable financial barrier. The commune of Lubunga in Kisangani is a rural entity inhabited mainly by low-income households. This promotes limited access to health care. This local reality corroborates the results of studies conducted in African counties which demonstrate that geographic distance combined with chronic stockouts of subsidized antimalarials in state facilities forces rural populations into severe economic trade-offs (Asante et al, 2021; Kibwana et al, 2024). Lacking public supply, these low-income rural households are constrained to acquire artemisinin-based combination therapies (ACTs) from the informal private sector, where price speculation is common.

We noted in this study that the costs of care associated with malaria borne by household in Kisangani are exponential, and that health coverage does not work as it should in our country. We therefore believe that access to primary health care is limited. This requires the implementation of a good health policy in order to lighten the burden on households. Consequently, as long as the rollout of universal health coverage does not integrate strict regulations and a continuous supply for public hospital pharmacies, the cost of medicines will continue to widen the gap of healthcare inequity between the city center and the rural periphery. This local reality matches the results from Kibwana et al. (2024) and Eneh et al. (2024), showing that medicines expenses are the main part of the direct cost of malaria care. For rural or peri-urban families living under the poverty line, having one or two cases of malaria in the same month forces tough financial choices. Families often have to go into debt, sell their livestock or work tools, or cut down on food and school budgets for their children.

In this study, the association between healthcare facilities and between years reflect the influence of economic conditions, including purchasing power of population, the depreciation of the Congolese franc, and the cost of medicines procurement. In this context, malaria remains not only a major public health problem but also a significant source of household impoverishment; this situation could be exacerbated by the low level of household revenue. The economic burden on rural households, where malaria imposes significant financial strain, limits their ability to combat the disease, particularly due to the lack of accessible health centers. Faced with this situation, Gashema et al., (2025) estimate that the costs of malaria care often favors the use of self-medication, one of the main reasons for which is the low economic level. This practice is always accompanied by multiple harmful consequences, including resistance to the disease or drug complications. Kibwana et al., (2024) consider that in Africa the linked to malaria care are high given its endemic

nature, while family burdens are enormous, such as school fees, food and daily life. Which sufficiently justifies the limited access to health care. Several factors favor the resurgence of malaria, such as the lack of essential drugs and adequate medical equipment to better make the diagnosis. For financial or cultural reasons, we suppose that patients often wait until the illness worsens before seeking medical attention (Isibor et al, 2011).

An uncomplicated case of malaria then develops into severe malaria (with severe anemia or cerebral malaria), which multiplies costs due to the need for hospitalization, injectable treatments (artesunate or quinine), intravenous fluids, and even emergency blood transfusions. In addition to the strict antimalarial, hospital prescriptions frequently include a multitude of adjuvants (antipyretics for fever, vitamins, antibiotics in case of suspected co-infection), which lengthens the overall pharmaceutical bill remaining as a direct cost to the household. Healthcare financing therefore relies predominantly on direct payments by families at the time of the morbid episode, transforming the cost of care into a catastrophic impoverishment factor for households living below the poverty line.

4. CONCLUSION

It is impossible to overlook the extent to which malaria, in all its forms, endangers the lives of countless people in Kisangani, as well as the severe impact it has on vulnerable and impoverished households when healthcare costs are taken into account. For both rural and urban households, the cost of malaria treatment remains a serious issue. Given its endemic nature, the resurgence of malaria entails exorbitant costs; this necessitates improved case management and, above all, the implementation of urgent preventive measures—specifically, addressing poor sanitation and environmental hazards, and ensuring access to primary healthcare.

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Author Contributions

Aimé Bulaya Botchaka conceived the research topic and carried out the data collection, Raymond Assani Ramazani processed and formatted the text, and the other authors reviewed and funded the typing and printing of the text.

Informed consent

Written & Oral informed consent was obtained from individual participants included in the study.

Conflicts of interests

The authors declare that they have no conflicts of interest, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Ethical approval & declaration

The study was done in conformity with ethical guidelines. Participation was entirely voluntary, and all respondents provided informed consent. The participants' anonymity and confidentiality were ensured, and the data obtained were utilized purely for the study. The ethical guidelines for Human Subjects are followed in the study.

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Data and materials availability

All data related to this study are included in the article.

REFERENCES

1. Asante KP, Owusu-Agyei S. & Cairns M. Health-seeking behaviour and cost of fever treatment to households in a malaria-endemic setting of Ghana. BMJ Open, 2021;11(9), e052224.

2. Aubry P, Gaüzère B. Malaria: Global epidemiology, situation in sub-Saharan Africa, and control challenges. News in Infectious and Tropical Diseases, 2019;41(2), 85-98.
3. Bouyssou I, Menard D. Current Challenges in the Fight Against Malaria in Sub-Saharan Africa and Transmission Dynamics. Journal of Parasitology / Medical Publications, 2023;109(6), 512-525.
4. Caminade C, Kovats S, Rocklov J, Tompkins AM, Morse AP, Colón-González FJ, Stenlund H, Martens P, Lloyd SJ. Impact of climate change on global malaria distribution. Proceedings of the National Academy of Sciences USA, 2014;111(9), 3286–3291.
5. Diouf I, Rodriguez Fonseca B, Caminade C, Thiaw WM, Deme A, Morse AP, Ndione JA, Gaye AT, Diaw A, Ndiaye MKN. Climate variability and malaria over West Africa. The American Journal of Tropical Medicine and Hygiene, 2020;102(5), 1037–1047. https://doi.org/10.4269/ajtmh.19-0062.
6. Eneh S, Onukansi F, Ikhuoria O, Ojo T. Designing and Deploying Custom Ringtones on Mobile Phones to Promote Malaria Vaccination in Africa: Can the Technology Acceptance Model (TAM) Help? Malaria Journal, 2024;23(1), Article 325. https://doi.org/10.1186/s12936-024-05134-3.
7. Gashema P, Kagame J, Iradukunda PG, Siddig EE, Tessema SK, Tegegne MA, Mazaba ML, Fallah M, Ngamije D, Harelimana JD, Muvunyi CM. Mapping Plasmodium falciparum mutations in Africa: A critical review of emerging drug resistance and implications for malaria control. International Journal of Infectious Diseases, 2025;159, Article 108033. https://doi.org/10.1016/j.ijid.2025.108033.
8. Hanitriniaina. Assessment of Population Exposure to Malaria Risks on a Global Scale. (Thesis / Master's Thesis in Epidemiology), University of Antananarivo, 2017.
9. Isibor JO, Igun E, Okodua M, Akhile M, Esibor AO, Adagbony E. Co-infection with malaria parasites and Salmonella typhi in patients in Benin City, Nigeria. Annals of Biological Research, 2011;2(2), 361-365.
10. Kanga M. Statistical Analysis of Malaria-Related Mortality in the Democratic Republic of the Congo: Focus on the Burden Among Children Under Five. Congolese Journal of Public Health, 2021;13(2), 74-88.
11. Kibwana E, Kapulu M, Bejon P. Controlled human malaria infection studies in Africa: Past, present, and future. Current Topics in Microbiology and Immunology, 2024, 445, 337–365. https://doi.org/10.1007/82_2022_256.
12. Li J, Docile HJ, Fisher D, Pronyuk, K, Zhao L. Current status of malaria control and elimination in Africa: Epidemiology, diagnosis, treatment, progress and challenges. Journal of Epidemiology and Global Health, 2024;14(3), 561–579. https://doi.org/10.1007/s44197-024-00228-2.
13. Losimba Likwela J, D'Alessandro U, Donnen P, Wilmet Dramaix M. Mapping Malaria Risk and the Influence of Environmental Factors in an Equatorial Urban Setting: The Case of Kisangani. Médecine et Santé Tropicales, 2018;28(2), 184-191.
14. Maketa V, Kulungu JF, Mitashi P. Ultra-sensitive malaria rapid diagnostic test and treatment for malaria prevention in DRC (UltraPYRAPREG). Trials, 2022;23(1), 963.
15. Ministry of Planning & Ministry of Public Health of the DRC. Demographic and Health Survey (DHS-DRC 2013–2014). ICF International, Rockville, Maryland, USA, 2014.
16. National Malaria Control Program (NMCP-DRC). Annual Report on Epidemiological and Statistical Surveillance of Malaria in the DRC and in Tshopo Province. Ministry of Public Health, Kinshasa/Kisangani, 2011.
17. Nkumama IN, O'Meara WP, Osier FH. Changes in malaria epidemiology in Africa and new challenges for elimination. Trends in Parasitology, 2017;33(2), 128-140.
18. Olawade DB, Wada OZ, Ezeagu CN, Aderinto N, Balogun MA, Asaolu FT, David-Olawade AC. Malaria vaccination in Africa: A mini-review of challenges and opportunities. Medicine, 2024;103(24), Article e38565. https://doi.org/10.1097/MD.0000000000038565.
19. Oyegoke OO, Akoniyon OP, Ogunsakin RE, Ogunlana MO, Adeleke MA, Maharaj R, Okpeku M. A systematic review and meta-analysis of malaria test positivity outcomes and programm interventions in low transmission settings in Southern Africa, 2000–2021. International Journal of Environmental Research and Public Health, 2022;19(11), Article 6776. https://doi.org/10.3390/ijerph19116776.
20. Sanogo. Malaria as a Major Global Public Health Problem: Mapping Populations at Risk. Epidemiology and Community Health, 2021;75(4), 312-325.
21. Savi MK. An overview of malaria transmission mechanisms, control, and modeling. Medical Sciences, 2022;11(1), Article 3. https://doi.org/10.3390/medsci11010003.
22. WHO. World Health Organization. Malaria (Fact sheet). World Health Organization, Geneva, Updated 4 Dec 2025.
23. WHO. World Health Organization. Report of December 8, 2022: Global Estimates of Malaria Mortality and the Impact of the COVID-19 Pandemic. World Health Organization, Geneva, 2022.
24. WHO. World Health Organization. World Malaria Report 2020: 20 Years of Progress and Challenges. World Health Organization, Geneva, 2020.
25. WHO. World Health Organization. World Malaria Report 2023. World Health Organization, Geneva, 2023.
26. WHO. World Health Organization. World malaria report 2024. Geneva: World Health Organization; 2024.