Original Article

Costs of treatment of children affected by severe malaria in reference hospitals of Kinshasa, Democratic Republic of Congo

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Abstract

Introduction: Malaria remains a real problem of public health. Its hospital care generates important expenditures for affected households. The present study aimed to estimate direct and indirect costs of severe child malaria in reference hospitals in Kinshasa.

Methodology: This prospective study included 1,350 children under 15 years of age suffering from severe malaria. The study was performed between 1 January and 30 November, 2011. Data were collected in nine reference hospitals. The studied parameters were direct pre-hospital costs, direct hospital costs, and indirect costs. Costs were assessed from the household point of view.

Results: Median costs associated with the disease ranged from 114 USD in confessional hospitals to 173 USD in state hospitals and 308 USD in private hospitals. Direct pre-hospital median costs ranged between 3 and 11 USD. Direct hospital costs reached 72 USD in confessional hospitals, 139 USD in state hospitals, and 254 USD in private hospitals. Indirect costs ranged from 22 USD in state hospitals to 30 USD in confessional hospitals and 46 USD in private hospitals, regardless of the status of the accompanying parent or guardian. Factors explaining the variability of costs were the neurological form of malaria, indirect recourse to hospital, socioeconomic level, type of prescribing person, child's status upon leaving the hospital, and child's transfusion status.

Conclusions: The care of severe child malaria appeared to be expensive in private and state hospitals. A state subsidy of health care and regulation of the private sector would contribute to the reduction of malaria's financial impact.

Key words: direct and indirect costs; severe malaria; households; Kinshasa.

J Infect Dev Ctries 2014; 8(12):1574-1583. doi:10.3855/jidc.4622

(Received 24 December 2013 – Accepted 04 September 2014)

Introduction

Severe malaria remains a major problem of public health. Tropical and subtropical regions register about 95% of deaths [1]. According to the World Health Organization (WHO), at least 40% of the 655,000 deaths caused by malaria registered in the world in 2010 occurred in the Democratic Republic of Congo (DRC) and in Nigeria [2]. Healthcare expenditures are considerable; in endemic countries, various scientific studies showed that malaria generates catastrophic losses for households, both in terms of direct and indirect expenditures [3,4-6]. In the DRC, malaria represents a significant economic and social burden. Households dedicate an important part of their financial resources to the medical attention of malaria, as the social security system is almost non-existent [7,8]. The disease requires often pauperized households to dedicate their limited resources to pay hospital costs. Knowledge about the weight of severe malaria on the household economy in urban areas is scarce. The present study aimed to estimate the direct and indirect costs for households, generated by the required medical attention, of severe child malaria in Kinshasa reference hospitals and hospital centers.

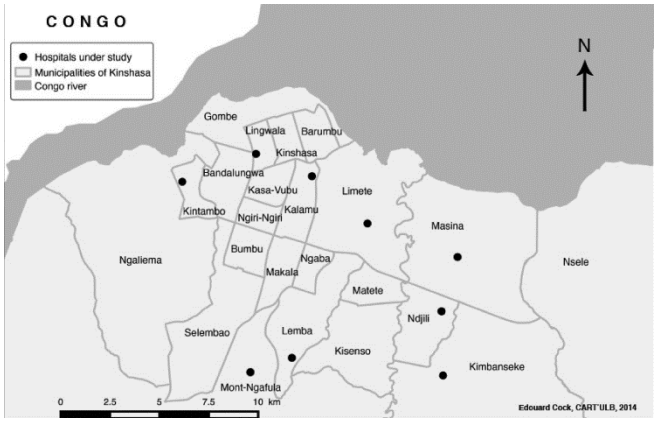
Methodology

Setting and location

The city-province of Kinshasa is the capital of the DRC and counts 24 urban and peri-urban municipalities. Urbanized zones occupy 20% of the region. It is subdivided into six sanitary districts and 35 health areas, all of them operational. There are more than 30 reference hospitals and hospital centers, either public, private, or confessional. The population covered by all these structures is estimated to be 10 million people, over a 9,965 square kilometer area,

according to the latest statistics reported by the Health and Demographic Survey (EDS) [9]. Malaria prevalence varies according to the geographic area, reaching 4% in urban and 65% in peri-urban areas [10,11]. Data were collected in nine reference hospitals of Kinshasa (three state hospitals, three private hospitals, and three confessional hospitals). According to the geographic location and the epidemiological status of the disease (area of malaria transmission) in Kinshasa, two hospitals were selected in the low transmission area, while seven hospitals were located in the high transmission zone. The approximate location of selected hospitals is represented by black dots in Figure 1.

Figure 1. A map of Kinshasa (RDC) showing the location of the hospitals under study



Target population and subgroups

The population of study included children under 15 years of age suffering from severe malaria who were accompanied by an adult (parent/legal guardian). Children were subdivided into two groups according to their age; the most vulnerable group included children under five years of age, and the second group included children over five years of age. Children were also distinguished according to the level of malaria transmission in their residential area (low transmission *vs*. high transmission area). Finally, they were also categorized according to the type of hospital to which they were admitted: state, private, or confessional.

The diagnosis of severe malaria was confirmed if the blood smear or thick blood smear was positive for *Plasmodium falciparum* and was associated with at least one of the clinical signs and/or biological signs of severity as fixed by WHO in 2000 [12,13].

Type of study, timeframe and study perspective

The present prospective study included 1,350 children affected by severe malaria; they were followed from admission until they left the hospital either because of death or recovery. Direct and indirect costs related to treatment for households, before and during the hospital stay, were estimated. The study was carried out between 1 January and 30 November, 2011 (an 11-month period), in the nine hospitals that were grouped into three categories: state, private, and confessional. Costs were estimated from the point of view of the paying household.

Cost items and description

Direct pre-hospital expenditures included costs of self-medication, consulting at the health center, traditional therapy for children affected by the indirect resort (taken to the hospital after being cared either by self-medication or after consulting the health center and/or after resorting to traditional therapy).

Direct hospital costs were subdivided into two categories: (i) direct medical expenditures, which included consulting costs upon admission and during the hospital stay, as well as costs related to additional tests and medicines (antimalarial drug and adjuvants); and (ii) direct non-medical costs, which included food expenditures, transportation costs, and informal costs (tips or bribes).

Indirect costs included those linked to working days lost by the accompanying persons or legal guardians who were professionally active or not, during the child's sickness.

Global expenditures of the disease were obtained by summing direct pre-hospital costs, direct hospital costs, and indirect costs.

Currency, price date and conversion

The reference year for all costs in this study is 2011. Costs were converted from Congolese Francs (CF) to US Dollars (USD) using the 2011 average exchange rate (1 USD = 1,000 CF).

Data collection

A structured questionnaire was used to collect the data.

For socioeconomic and demographic status of households, the method used to elaborate the economic level indicator was inspired by the methodology applied in demographic and health surveys [9]. The main steps of such method focus on the dichotomy of variables, the estimation of each variable's weight and of the economic score. Scores were further divided on the basis of household tertiles.

The household was characterized as poor if economic scores fell below the bottom tertile.

For the type of care before hospitalization, different types of indirect resorts (pre-hospital) were investigated; these included self-medication, health center or church attendance, and traditional therapy (before consulting the hospital).

Finally, data about direct pre-hospital costs and direct non-medical expenditures were also collected.

Consent was obtained from the person(s) accompanying the child (parent/legal guardian).

A pre-established form allowed for collection of clinical, biological, and anthropomotric data upon admission and during the follow-up of the sick child. Data on direct medical costs were collected from hospital invoices and accounting registers. Collection of all data was ensured by nursing sciences degree students who were trained beforehand.

Cost approach and cost estimation

An incidence-based approach was applied to estimate the cost of illness of severe malaria treatment, per episode, from a household perspective.

Expenditures consecutive to the hospital stay were recorded in real time. Households were invited to present their bills and to declare the amounts paid out for medication bought outside the hospital. Direct pre-hospital costs were estimated according to the components approach (or ingredient approach) [14], which consists in asking the accompanying person about the different pre-hospital recourses and the price paid for each of them. That same method was used to estimate direct non-medical costs, in particular costs of transportation to the hospital and visits of other family members. Families were asked to declare the cost of a round trip. The daily food cost for patients and people permanently staying with the child at the hospital was also included [14]. Indirect costs were estimated according to the human resources approach, based on the real loss of income attributable to the disease [15-18]. As income is often underestimated in DRC, global self-declared expenditures were considered instead of income. Several authors consider global self-declared expenditures to be a better proxy of household purchasing power than the sum of self-declared income [19,20].

Ethical considerations

The study was approved by the Medical Inspection of the city-province of Kinshasa, the Kinshasa Provincial Ministry of Health, and the Ethics Committee of the Kinshasa School of Public Health. All persons accompanying the children had consented to participate to the survey, either orally and/or in writing.

Statistical analyses

Statistical analysis of data was performed with Stata 12.0 software. According to the nature of compared variables, several statistical tests were used.

The Chi-squared test was used to compare proportions, and the Kruskall-Wallis or Mann-Whitney tests were used to compare distributions through their medians.

Finally, a multivariate analysis (quantile regression) was performed to identify factors linked to cost variability. Interactions tested between the hospital status, household socio-demographic characteristics, type of anterior care, clinical characteristics of the child upon admission, status upon leaving the hospital, and transfusion status were almost all significant. Considering the objectives and legal status of hospitals, a stratified approach was used. Three operational levels were constituted: the first level included state hospitals, the second level comprised private hospitals, and the last level included confessional hospitals.

A sensitivity analysis was conducted on direct and indirect costs to test the robustness of the assumptions and to investigate the impact of potential outliers on the database. The effects of a 20% change on the parameters of both indirect costs as performed in an earlier study [15,21] were tested. The level of significance was fixed at 0.05.

Results

Sample description

The sample included more males (57.2%) than females (male/female ratio = 1.3). In the three levels (state, private, and confessional hospitals), sex distribution was not homogeneous (p = 0.03). Three-quarters of the children were under five years of age. Median age (months) was statistically comparable in the three sites (Median [percentile 25-percentile 75]: 28[15-55], 34[16-66], 30[13-60], p = 0.08). When considering the transmission area (low *vs*. high) and the type of hospital, over half of the children originated from a high-transmission area in the three categories of hospitals (61.8%, 76.9%, and 86.0% of children, respectively, in state, private, and confessional hospitals).

The median duration of hospitalization was significantly higher in confessional and state hospitals compared to private hospitals (Median [percentile 25-

percentile 75]: 4[3-5], 5[4-6], 5[4-6]) ($p < 0.001$). There were more children who received transfusions in confessional hospitals (67.8%). The economic score differed according to the hospital; more than half of the children who attended state (65.1%) and confessional hospitals (57.1%) were below the bottom third of typically poor households. The indirect recourse to hospital was more frequently observed for children attending state (85.6%) and private hospitals (78.2%) ($p < 0.001$).

Estimation of the different costs

Table 1 summarizes the different categories of costs according to the type of hospital. Median costs associated with the disease ranged from 114 USD in confessional hospitals to 173 USD in state hospitals and 308 USD in private hospitals. The differences between the different types of hospitals were highly significant ($p < 0.001$).

Median direct pre-hospital costs reached 3 USD for children attending private hospitals and 11 USD for children attending state hospitals. A median cost of 7 USD was registered for children attending confessional hospitals.

Direct hospital expenditures ranged from 72 USD in confessional hospitals to 139 USD in state hospitals and 254 USD in private hospitals (significant differences with $p < 0.001$). Indirect costs (work stoppage of the active accompanying adult because of the child's disease) reached 22 USD in state hospitals, 47 USD in private hospitals, and 30 USD in confessional hospitals, regardless of the professional status of the adult (Table 1).

Table 2 illustrates the median costs associated with the disease per post and type of hospital. Direct pre-hospital costs included self-medication, consultation at the health center, and traditional therapy. Households that opted for self-medication spent between 0.2 and 0.3 USD in the three sites (no significant difference). On the other hand, households that atttended a health center before going to the hospital spent between 11 and 16 USD. Only households that attended private

Table 1. Median cost of medical attention of severe malaria, per category and type of hospital (USD**)

Categories of expenditures	n	A Median [p25-p75]	n	B Median [p25-p75]	n	C Median [p25-p75]	P*
Direct pre-hosp. cost	385	11 [0.7-18]	352	3 [0.3-11]	327	7 [0.6-17]	<0.001
Direct hosp. cost	450	139 [10-189]	450	254 [195-304]	450	72 [48-150]	<0.001
Indirect cost 1	450	22 [16-33]	450	46 [29-70]	450	29 [16-57]	<0.001
Indirect cost 2	440	22 [16-33]	435	47 [30-70]	409	30 [16-56]	<0.001
Cost of the episode	450	173 [136-289]	450	308 [246-378]	450	114 [78-216]	<0.001

**1 US Dollar (USD) = 1,000 Congolese Francs (CF) in 2011; A: state hospitals; B: private hospitals; C: confessional hospitals; *Kruskal-Wallis test; Pre-hosp: pre-hospitalization; hosp: hospital; Me: median; p25: percentile 25; p75: percentile 75 Indirect cost 1: for all households, whatever the professional status of the accompanying person Indirect cost 2: for accompanying employed persons.

Table 2. Analysis of the median cost of the malaria episode, per post and per type of hospital (USD**)

Post of expenditures (USD)	n	A Median [p25-p75]	n	B Median [p25-p75]	n	C Median [p25-p75]	P*
Direct pre-hosp. costs							
Self-medication	278	0.3 [0.2-0.7]	300	0.2 [0.3-0.6]	260	0.3 [0.6-1.1]	0.34
Health center	361	16 [10-12]	138	11 [9-13]	158	16 [12-21]	<0.001
Traditional therapy	0	0	2	20 [15-25]	10	15 [12-20]	
Direct hosp. costs							
Direct medical costs							
Consultation	450	9 [8-13]	450	10 [8-18]	450	7 [3-9]	<0.001
Medication	450	36 [27-60]	450	48 [32-68]	450	29 [24-36]	<0.001
Additional tests	450	16 [9-25]	450	38 [24-49]	450	5 [0-11]	<0.001
Hospital stay	450	39 [28-60]	450	133 [100-172]	450	31 [9-76]	<0.001
Direct non-medical costs							
Transportation	391	4 [2-6]	394	3 [2-6]	350	3 [1-5]	<0.001
Food	450	9 [7-11]	450	9 [7-12]	450	7 [3-11]	<0.001
Informal costs	24	3 [2-6]	2	7 [3-11]	4	2 [1-2]	

**1 US Dollar (USD) = 1,000 Congolese Francs (CF) in 2011; A: state hospitals, B: private hospitals, C: confessional hospitals; *Kruskal-Wallis test; Pre-hosp: pre-hospitalization; hosp: hospital; Me: median; p25: percentile 25; p75: percentile 7

and confessional hospitals declared having consulted a traditional therapist, with a cost ranging from 15 to 20 USD.

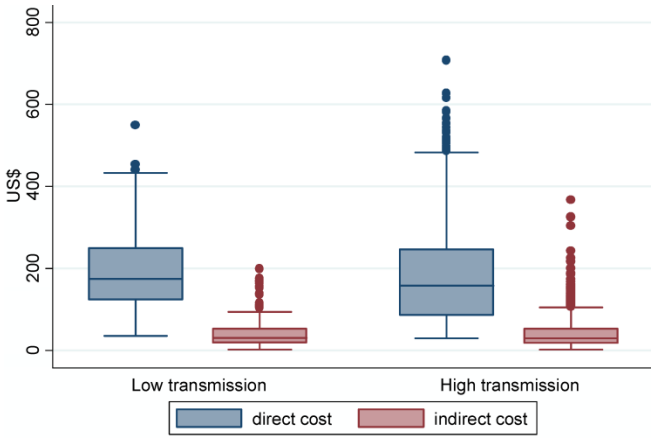
Direct hospital expenditures included direct medical and non-medical costs. The comparison between direct medical costs showed that consultation expenditures were more elevated in private and state hospitals. The medication costs (antimalarial and adjuvants such as perfusions, antibiotics, and blood transfusions) as well as costs associated with additional tests and hospital stays remained significantly higher in private hospitals ($p < 0.001$). In the three categories, the costs of medication and hospital stays were the three main posts of direct medical costs, accounting for, respectively, 75%, 79%, and 83% of expenditures in state, private, and confessional hospitals.

The comparison of direct non-medical costs showed a highly significant difference between the three types of hospitals. Median transportation costs ranged between 3 and 4 USD, food costs between 7 and 9 USD, and median informal cost between 2 and 7 USD. Median transportation and food costs were the main direct non-medical costs (81% in state and confessional hospitals, and 83% in private hospitals) (Table 2).

Results of the bivariate analysis are presented in Table 3; factors significantly influencing the disease median expenditures differed according to the type of hospital.

Regarding the neurological clinical picture, median costs were more elevated for comatose children in state and confessional hospitals. This difference was not observed in private hospitals. In private hospitals only, costs were found to differ significantly based on the presence or absence of severe anemia ($p < 0.001$). On the other hand, the existence of respiratory distress generated different costs in private and confessional hospitals ($p < 0.001$). In private and confessional hospitals, expenditures were higher for children who recovered compared to those who died during hospitalization. This cost difference was not significant for state hospitals. When considering the age of children, costs of medical care were higher for children < 5 years of age in state hospitals ($p < 0.05$). On the other hand, the situation was opposite in confessional hospitals ($p < 0.05$), where the costs were higher for children ≥ 5 years of age. No significant difference was observed in private hospitals. The late recourse to a hospital and blood transfusion generated an important cost in private and confessional hospitals. The prescriber and the type of recourse similarly influenced the difference of costs in the three categories of hospitals. On the other hand, the cost difference was higher for households managed by men in the state hospitals category. In private hospitals, the costs were statistically different for middle-income and well-off households compared to poor households. In confessional hospitals, expenditures were higher for households living in urban areas (low transmission) and for households managed by women (Table 3). Globally, the comparison of direct costs showed a significant difference based on the transmission area. Children residing in a low-transmission area were charged 16 USD more than those originating from a high-transmission area ($p = 0.02$). No significant effect of the transmission area was observed on indirect costs (Figure 2).

Figure 2. Direct and indirect costs per transmission pattern



Factors of variability for the median costs associated with the disease are presented in Table 4 through a multivariate analysis. Along with the bivariate analysis, the multiple regression showed that, in state hospitals, the child's age and delayed care did not influence increased costs. In private hospitals, results of the multivariate analysis highlighted a highly significant statistical relationship between the neurological form of severe malaria and increased costs. On the other hand, severe anemia, respiratory distress, and delayed care were not responsible for increased expenditures. The multivariate analysis also showed that, in confessional hospitals, respiratory distress, transfusion status, and residency area were not factors that increased costs (Table 4).

Table 3. Median cost of the malaria episode based on the clinical and socio-demographic features of the child as well as the characteristics of his/her family (USD**)

Clinical picture	n	A Median [p25-p75]	n	B Median [p25-p75]	n	C Median [p25-p75]
Severe anemia						
Yes	43	171 [120-242]	46	338 [253-468]^{s}	65	122 [92-224]
No	407	173 [137-227]	404	299 [240-369]	385	114 [76-214]
Neurological						
Yes	41	238 [163-282]^{s}	25	347 [309-492]	41	235 [137-389]^{s}
No	409	169 [133-225]	425	307 [246-372]	409	108 [76-203]
Respiratory distress						
Yes	65	196 [147-246]	130	328 [288-372]^{s}	82	201 [114-279]^{s}
No	385	171 [133-226]	320	293 [229-382]	368	106 [74-196]
Status upon leaving the hospital						
Death	24	161 [144-223]	38	247 [173-344]^{s}	18	68 [51-86]s
Recovery	426	174 [136-229]	412	309 [250-379]	432	119 [81-217]
Age of the child						
< 5 years	351	179 [141-231]^{s}	322	314 [245-396]	334	106 [75-196]^{s}
≥ 5 years	99	155 [107-222]	128	302 [247-369]	116	182 [106-206]
Delay of medical attention						
≥ 48 hours	302	168 [131-226]^{s}	380	313 [250-386]^{s}	308	141 [75-233]^{s}
< 48 hours	148	182 [146-237]	70	269 [197-317]	142	106 [84-135]
Blood transfusion status						
Transfused	163	179 [120-252]	207	334 [277-405]^{s}	305	107 [78-196]^{s}
Not transfused	287	171 [140-217]	243	285 [223-347]	145	162 [79-227]
Sex of head of household						
Male	419	177 [139-230]^{s}	426	309 [247-380]	409	109 [76-212]^{s}
Female	31	137 [115-192]	24	274 [225-322]	41	185 [121-244]
Economy score tercile						
< 5.9	271	174 [138-222]	152	268 [201-335]^{s}	256	117 [82-218]
5.9-13.1	103	177 [137-240]	128	301 [244-376]	107	109 [69-216]
≥ 13.2	76	172 [119-277]	170	333 [290-411]	87	115 [74-215]
Transmission pattern						
High transmission	278	168 [137-230]	346	301 [246-386]	387	110 [77-208]^{s}
Low transmission	172	179 [130-226]	104	314 [254-355]	63	166 [84-242]
Prescriber						
S & GP	45	300 [219-396]^{s}	56	321 [267-396]	30	217 [113-351]^{s}
S or GP	405	167 [128-219]	394	306 [244-376]	420	111 [77-208]
Recourse for health care						
Direct	65	127 [82-160]^{s}	98	271 [216-347]^{s}	123	83 [62-120]^{s}
Indirect	385	182 [143-237]	352	315 [215-383]	327	141 [89-227]

** 1 US Dollar (USD) = 1,000 Congolese Francs (CF) in 2011; A: state hospitals; B: private hospitals; C: confessional hospitals; ^{S}: significant Kruskal-Wallis or Mann-Whitney test; GP: general practitioner; S: specialist

Table 4. Multivariate analysis (median regression) of factors associated with variability of costs linked to malaria (USD**), based on the type of hospital

	B	SE(b)	P
State hospital - Cost of malaria episode (n = 450; R^2 = 0.24)			
Sex of head of household			
Male	0		
Female	43.9	17.9	0.014
Clinical picture			
Neurological form (y/n)	58.2	16.6	<0.001
Prescriber			
S & GP	98.9	16.1	<0.001
S or GP	0		
Type of recourse			
Direct	0		
Indirect	60.5	12.8	<0.001
Private hospital - Cost of malaria episode (n = 450; R^2 = 0.17)			
Clinical picture			
Neurological form (y/n)	58.2	16.6	<0.001
Type of recourse			
Direct	0		
Indirect	27.9	15.7	0.026
Socioeconomic level			
< 5.9	0		
5.9-13.1	43.1	17.1	0.012
≥ 13.2	63.3	16.6	<0.001
Status upon leaving the hospital			
Recovery	46.3	21.2	0.04
Death	0		
Blood transfusion status			
Transfused (y/n)	46.4	13.6	0.001
Confessional hospital - Cost of malaria episode (n = 450; R^2 = 0.22)			
Type of recourse			
Direct	0		
Indirect	34.5	9.6	<0.001
Delay of medical attention			
< 48 hours	0		
≥ 48 hours	24.6	9.1	0.001
Clinical picture			
Neurological form (y/n)	80.4	14.6	<0.001
Sex of head of household			
Male	0		
Female	41.8	14.3	0.004
Prescriber			
S & GP	50.3	16.5	0.002
S or GP	0		
Status upon leaving the hospital			
Recovery	52.2	20.3	0.011
Death	0		
Age (years)			
<5 years	0		
≥ 5 years	50.2	9.8	<0.001

**1 US Dollar (USD) = 1,000 Congolese Francs (CF) in 2011; GP: general practitioner; S: specialist; y/n = yes/no; SE (b): standard error; b: coefficient

Sensitivity analysis

A sensitivity analysis allowed for an estimation of the variability of direct and indirect costs of malaria based on the different parameters included in the study, with the aim of testing the robustness of the results. The multivariate sensitivity analysis was performed on the basis of two scenarios. In the first scenario, the lowest costs (pre-hospital and non-medical costs) were used, while the second scenario considered the most elevated costs (medical and indirect costs). The sensitivity analysis conferred a good robustness to the results, as they were stable when considering the malaria transmission area (low *vs*. high transmission) and the type of hospital (state, private, or confessional).

Discussion

This study allowed an analysis of the costs associated with the medical care of severe child malaria according to the type of hospital attended. The estimation of costs allowed for distinction between three groups of households: households paying very expensive costs in private hospitals, households paying intermediate expenditures in state hospitals, and households paying lower expenditures in confessional hospitals. Our results confirm the conclusions of numerous studies carried out in Nigeria, Ethiopia, Sudan, Burkina Faso, and Sri Lanka that found that the medical attention of children suffering from severe malaria in private hospitals was associated with the highest expenditures [16,20,22-25]. In this study, the differences in treatment costs observed between public and private hospitals *vs*. confessional structures confirmed the hypothesis of a lack of adjustment and of under-financing by the Congolese state. In the DRC, the part of the national budget assigned to health is very variable and remains generally below the 15% threshold decided and ratified by numerous countries in 2001 through the Abuja declaration. Part of the budget assigned to health never exceeded 5% [26]. For comparable clinical pictures, the costs of malaria in Kinshasa hospitals are much higher than costs registered in hospitals in Vietnam [15] and Nigeria [4]; only the state subsidies can justify such difference.

In the present study, expenditures were analyzed and subdivided into three main categories: direct pre-hospital, direct hospital, and indirect costs. Direct pre-hospital costs (pre-hospitalization) differed according to the type of recourse (self-medication, health center, and traditional therapy); they were higher for households who resorted to traditional therapists and for those who consulted on-the-spot health centers before going to the hospital, compared to households who opted for self-medication. Our results confirm the observations of Sicuri *et al*. in Ghana, Tanzania, and Kenya [27], and those of Couitchéré *et al*. in Ivory Coast [28]. In terms of direct hospital costs, our study showed that medication and hospital stays constitute the highest proportion of costs. This trend also confirms the results of previous studies [22,23,29,30]. The lack of availability of basic medication forces households to buy medicine by themselves in private profit-seeking pharmacies. Unofficial gifts or tips given to the staff, and transportation costs for households living far from the reference hospitals increase the financial charge to some households.

According to our results, estimated indirect costs were lower than direct hospital costs, which differed from the results of Chuma et al. [5], and Attanyake et al. [16], who reported higher indirect costs in their studies. Nevertheless, our conclusions are very similar to the results of Koné *et al*. [23]. The comparison of costs associated with severe malaria based on the transmission area highlights a higher direct cost for households residing in low-transmission areas. This difference was not observed for indirect costs. The potential role of an endemic status of the disease with regard to expenditures has already been documented by other authors [4,5]. On the contrary, indirect costs were estimated to be higher in low-transmission areas in a previous study by Chuma *et al*. [5].

Data analysis allowed us to highlight variability factors of costs associated with malaria. The difference of recourse to medical attention influenced the cost of care. Two groups could be distinguished: one including people who directly consulted the hospital (lower cost) and the other one including people who opted for an indirect recourse (higher cost). Indeed, several authors [23,31] showed that indirect recourse increases expenditures. Households that opted for less expensive therapeutic itineraries did not consider the cost-efficiency ratio of these recourses. The ignorance of households in relation to the choice of an appropriate therapeutic itinerary appeared to be a factor that increased the costs associated with malaria in our study.

Our results show that the household economic status significantly influences the costs of hospital care of severe malaria. Poor households paid significantly less than did well-off families. Nevertheless, costs remain out of reach of their paying capacity. Health expenditures not only depend on the socioeconomic status, but also on the child's clinical picture and the

care delay (time before taking the child to the hospital). Costs associated with the neurological form remained clearly higher compared to other clinical forms (anemia and respiratory distress); our results thus confirm the studies of Sicuri *et al*. performed in Tanzania [27], and of Mulumba *et al*. performed in the DRC [29]. The prescriber, the child's status upon leaving the hospital, and the child's age did not equally contribute to the costs in the three categories of hospitals. Indeed, costs associated with blood transfusion in case of anemia were far from being uniform in Kinshasa hospitals. Blood transfusion appeared to be a factor that accounted for increased costs, especially in private hospitals. This observation is in agreement with a previous study by Kiyombo *et al*. performed in Kinshasa [32].

The present study showed the burden of severe malaria at the household level. Macroeconomic estimations of the malaria burden, based on the combination of studies carried out in different contexts but on a national scale, which would consider the differences in transmission and geographic and epidemiological variations between provinces, could be of great importance. Such data would also provide information on the modelling of the cost-efficiency ratio of operations in different epidemiological contexts.

Furthermore, such data would be helpful in informing on how to distribute the scarce resources, considering the economic burden that malaria represents for the most vulnerable populations.

Limitations of the study

The present study had some limitations. First, it included cases of severe malaria, and did not take mild cases into account. Secondly, the study mainly focused on the direct and indirect costs of seeking malaria treatment to the exclusion of intangible costs and post-hospital costs, as well as prevention costs. Expenditures associated with the funerals of deceased children were not taken into account, which can lead to an underestimation of costs. The low number of households having declared informal costs would clearly generate an underestimation of treatment costs incurred by households. Previous studies have shown that, when considering informal payments, the global expenditures of treating malaria can be three times higher than the costs declared by healthcare providers [27,33,34].

Conclusions

Expenditures associated with severe malaria in Kinshasa hospitals vary according to the legal status of the hospital attended. The results of our study reveal that the majority of households cannot face expenditures generated by the hospital care of severe malaria. Prevention and state subsidy of health care remain the most efficient means to minimize expenditures. Regulating health expenditures in private and state hospitals, as well as implementing a national system of risk sharing seem necessary to reduce the financial burden of malaria, especially for poor and vulnerable populations.

Authors' contributions

FI is the main author: he designed the study, participated in data collection and analysis, and also wrote the manuscript and participated to the read-through. AL participated to the manuscript writing, data analysis and marking of the final version. LO participated to data interpretation and marking of the final version. FT participated to the manuscript writing, the methodology and read-through. MD participated to data collection and analysis, manuscript writing and read-through. All authors read and approved the final version.

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Conflict of interests: No conflict of interests is declared.