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Modelling the cost of Paediatric Malaria Treatment in a Rural County in Kenya; Do Indirect Costs Matter? A cross sectional Survey

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ABSTRACT

Objective: The objective of this study was to develop a comprehensive model for the cost of treatment of paediatric malaria in a resource strained rural setting; Homa-Bay county, Kenya. We sought to investigate the main contributors of total cost and the contribution of indirect costs to the total cost of care.

Design: A health facility based cross sectional survey targeting paediatric patients.

Setting: The study was conducted in 13 health facilities ranging from level II to level V in Homa Bay County which is in the Eastern shores of Lake Victoria, Kenya.

Participants: The study enrolled 254 children (139 males and 115 females) all of who completed the study.

Primary and secondary outcome measures: The primary outcome measure was the total cost of care for peaditric malaria. This was measured through a verbal autopsy from an exit interview with caregivers of children

Results: A total of consented 254 respondents from 13 health facilities were interviewed. Age, number of days spent at the health facility, being treated at a level V facility, medical officer prescribing and seeking initial treatment from a retail shop were found significant predictors of cost.

Conclusion Higher level health facilities in Homa-Bay County are more costly hence barring the poorest from obtaining paediatric malaria care from here where the more specialized medical workers are stationed. Indirect intangible costs may burden patients even when direct fees are have been waived in public government facilities.

Keywords: Modeling, Cost of treatment, Paediatric malaria, Homa-Bay

Strengths and limitations of this study

Strengths

- This study was conducted only four years after implementation of devolution of health in Kenya. It is therefore a very early attempt to investigate health systems performance post devolution.
- Many previous malaria costing studies have focused on either direct costs only or adult patients only. This study includes both direct and indirect costs including opportunity cost of time lost for caring for the patient.
- Robust statistical analysis using stepwise regression analysis thereby taking care of any possible confounders to the study findings

Weaknesses

- The data was collected solely by verbal autopsy through exit interview of caregivers. This may weaken validity of the findings as some respondents may have been fatigued by the stay in the hospital
- The study was conducted in one county and yet the counties in Kenya are varied geographically and socioeconomically. This limits the generalisability of the findings

Funding

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INTRODUCTION

Cost of health care services in sub-Saharan Africa is a major impediment to attainment of Universal Health Coverage [1]. Malaria is a major cause of paediatric morbidity and mortality in this part of the world [2,3]. The burden of malaria treatment on households is felt most among poor rural populations [4]. Understanding the cost drivers for the treatment of paediatric malaria is important for devising strategies for optimizing such costs. Cost modeling for malaria treatment has previously focused on adult patients and ignored indirect costs such as cost of forgone earnings and cost of transportation to and from the heath facility [5]. When free treatment policy for malaria in children under the age of 5 years was enforced in Kenya in 2005, it was largely assumed that the cost of such treatment would be free. This assumption ignored indirect and intangible costs yet studies have shown that both direct and indirect costs are significantly associated with the risk of catastrophic household health expenditure [6]. It has also

been reported that, in Kenya, there are several unofficial user fees often paid by the patients despite their official scrapping for paediatrics [7]. This necessitates costing malaria treatment from a patient perspective in order to capture all costs incurred. The objective of this study was to develop a comprehensive cost model for the treatment of paediatric malaria in a resource strained setting; Homa-Bay county, Kenya.

METHODS

Study setting

Kenya is classified by the World Bank as a lower middle income country [8]. The under 5 mortality rate in Kenya currently stands at 45.6 per 1000 live births (9)**.** Homa-Bay is one of the 47 counties that were created in Kenya in the year 2010. It is a rural county with a predominantly peasant economy. Homa-Bay County has poverty levels above the national average and some of the poorest child health indicators in the Kenya. For example, the county specific under five mortality reported in 2016 was 130 per 1000 live births (10). The County is located in the Eastern shores of Lake Victoria hence has climatic conditions that favour malaria endemicity, with pregnant women and children bearing the greatest burden of the disease.

Study design

The study was conducted as a cross sectional survey. This design was considered appropriate since it is convenient and cost friendly to collect all the data from the patients in one encounter. Both the exposures and outcome were examined at the same time.

Costing Approach

A bottom up approach of costing with a patient perspective was adopted. The total costs were summed up from individual expenditures (cost ingredients) incurred by the patient in the process of procuring care for the child with malaria. In this study, the costing was computed based on all direct and indirect monetary expenditures incurred by the parent or guardian in connection to treatment of the child.

Target population

The target population comprised all children below 13 years exiting government health facilities in Homa Bay County after treatment of malaria during the period of study.

Sampling

The sample size was based on the findings of the Melody study [11] which reported that for cost outcomes, a sample size of approximately 200 would be required to generate a 95% CI precise to within ±10% of the mean. A multistage sampling approach was adopted. First, the county was divided into eight zones based on the eight sub-counties. The health facilities were then stratified based on service provision levels from level two to level five. The County had no level one facility, three level five facilities, and no level six facility at the time of data collection. All the three level five facilities were included in the sample. Therefore, actual facility sampling was done only for levels 2, 3 and 4 facilities. A total of 13 facilities were sampled as shown in table 1. From each facility, approximately 20 patients were sampled using the purposive sampling approach where every paediatric patient exiting after treatment of malaria was approached by the research assistant for recruitment. If the target number of 20 was not reached in one day, a repeat of the process was done the following day after which no more repeats were done irrespective of the total number interviewed. This process generated a sample size of 254 participants.

Table 1: Number of health facilities and participants sampled in the study

Facility level	2	3	4	5	**Total**
Number of facilities	13	9	12	1	**35**
Number sampled	4	3	5	1	**13**
Number of participants sampled	68	54	100	32	**254**

Recruitment of study participants

A research assistant approached a caregiver of a patient who had just been seen for malaria. This was followed by self introduction after which the caregiver was requested to read the consent explanation and consider consenting. If they were not able to read, it was read to them in a language that they best understood. Upon giving consent, the interview guide was administered.

Data collection

Data on contributors to cost as well as cost of paediatric malaria was collected by use of a structured exit interview guide. Both direct costs such as out of pocket payments and cost of medicines purchased as well as indirect costs such as transport, food, waiting time and opportunity cost incurred while taking care of the sick child were measured.

Quality assurance

Data collectors were trained for two days on the survey procedure in a classroom setting and then practised in the pre-test health facility outside the data collection area. The pre-test health facility was in Migori County which neighbours Homa-Bay County. Data collection instruments were examined by supervisors and other experts to ascertain their quality.

Data analysis

Data was checked for completeness, cleaned, sorted and coded. This was followed by data entry into an excel spreadsheet in readiness for analysis by use of the R statistical software. Summary of descriptive data on cost of treatment was done on R software. The cost of treatment was then modelled on R statistical package using a stepwise multiple linear regression approach.

Ethical Considerations

All principles pertaining ethical conduct of research with human subjects were adhered to in this study as embodied in the declaration of Helsinki. Ethical approval was obtained from the Kenyatta National Hospital/University of Nairobi-Ethics and Review Committee (ERC Ref-**P389/05/2016**).

The Patient and Public Involvement statement

Patients and the public were first involved in this study at the conceptualization stage through a preliminary reconnaissance to understand the problem from a patient perspective.

Costing was done from a patient perspective thus focusing not on costs incurred by the health facilities but by the patients. The outcomes, total cost was measured by verbal autopsy from the participants

Feedback from the preliminary reconnaissance was used to improve methods of data collection as well as the data collection tool.

Patients were first fully informed about the process and purpose of the study and were only recruited upon informed consent

They were also informed of the time required to participate and that if they felt it was going to be too long for them, they were free to decline consent.

Once the whole study process is completed, meetings will be held with the participants to discuss what may be disseminated and manner of doing the same

RESULTS

The survey was conducted across various health facilities ranging from level 2 to level 5. Most of the participating children, 47.6% (121), were in level 4 facilities. Level 2 facilities had 26.8% (68) of the children, level 3, 21.3% (54) and level 5, 4.3% (11). Most participants, 55.5%(141), were 4-6 years old. Male participant children were 54.7% (139) while females were 45.3% (115). Most of the participants, 62.6% (159), travelled between 2 to 5 km to reach the health facility using mainly a motorcycle as the preferred means of transport 66.1% (168). After reaching the hospital, most of them, 72% (183), waited for about one hour to be served while 18.1%(46) were attended to within 30 minutes. Medical officers, 46.5% (118) were the majority of prescribers followed by clinical officers at 35.8% (91). Nurses prescribed to only 17.7% (45) of the respondents. Most caregiver-respondents, 70% (178), stayed in the hospital with their children for two days or less with most of them, 61.8% (157), describing the condition of their children at admission as not very sick. Most, 48 %(122), of the participants first sought medical care in a

community pharmacy outlet before proceeding to a government hospital. Table 2 is a summary of the baseline characteristics of the study participants.

Table 2: Sociodemographic characteristics of study participants

Factor	Number of children	%
Facility Level		
Level 2	68	26.8
Level 3	54	21.3
Level 4	121	47.3
Level 5	11	4.4
Age of child		
< 1	11	4.3
1 – 3	74	29.1
4 – 6	141	55.5
7 – 9	22	8.7
10 +	6	2.4
Sex of child		
Male	139	54.7
Female	115	45.3
Distance to health facility (Km)		
< 1	40	15.7
2 – 5	159	62.6
5 – 10	50	19.7
> 10	5	2.0
Mode of Transport to health facility		
Ambulance	2	0.8
Bicycle	13	5.1

Motorcycle	168	66.1
On Foot	55	21.7
Private Vehicle	4	1.6
Public Service Vehicle	12	4.7
Waiting Time		
< 30 Minutes	46	18.1
1 hr	183	72.0
2 hrs	10	3.9
3 hrs	7	2.8
3 + hrs	8	3.2
Prescriber		
Clinical Officer	91	35.8
Medical Officer	118	46.5
Nurse	45	17.7
Days of Stay at the facility		
1 – 2	178	70.0
3 – 4	38	15.0
5 – 7	38	15.0
Severity of Illness at admission		
Not Very Sick	157	61.8
Very Sick	97	38.2
Initial treatment site		
Community Pharmacy outlet	122	48.0
Dispensary	39	15.4
Government Hospital	36	14.2
Private Hospital	36	14.2
Religious Leader	16	6.3
Retail Shop	5	2.0

Modelling the cost of treating paediatric malaria

The model representing the cost of treating paediatric malaria in Homa-Bay County was developed by use of stepwise multiple linear regression analysis of the costing data collected from the exit interviews. The full model was first formulated as shown in table 3 followed by a reduced model shown in table 4.

Table 3: Full Model of the cost of treatment of paediatric malaria

Full model				
Parameter	**Parameter Esti. (se)**	**95% CI**	**t-Value**	**p-Value**
		LB – UB		
Age	85.9 (42.8)	20.4-159.4	2.00	**0.047**
Facility Level				
Level 3	27.8 (408.9)	-903.9 - 840.1	0.06	0.945
Level 4	220.8 (352.9)	-654.4 - 884.2	0.63	0.533
Level 5	739.8 (739.4)	-873.6 - 2,094.2	1.00	0.319
Distance to Facility				
2 – 5	-387.5 (263.7)	-883.1 - 225.8	-1.5	0.144
5 – 10	388.9 (352.8)	-873.6 - 593.1	-1.1	0.273
10 +	414.2 (620.1)	-1,230.5 - 1,229.6	0.7	0.506
Prescriber				
Medical Officer	600.6 (254.9)	91.6 - 1,150	2.40	**0.021**
Nurse	490.8 (298.5)	-323.7 - 906.3	1.60	0.104
Days of Stay	210.8 (62.8)	86.1 - 335.4	0.94	0.001
Waiting Time				

Within 1 hr	303.2 (238.2)	-224.9 - 776.9	1.30	0.206
Within 2 hrs	395.1 (459.9)	-673 - 1,242.9	0.90	0.392
Within 3 hrs	275.1 (514.6)	-884.5 - 812.9	0.50	0.594
Initial Treatment site				
Dispensary	158.8 (404.8)	-884 .5 - 812.9	0.40	0.696
Government Hosp	959.4 (815.5)	-595.1 - 2,612	1.20	0.242
Private Hosp	8.9 (291.1)	-458.7 - 685.7	0.03	0.976
Religious Leader	420.4 (302.4)	-38.8 - 1,223.4	1.40	0.168
Retail Shop	1,440 (683.9)	119.2 - 2,9442.7	2.10	**0.038**

R^2 = 68%, R^{2-} Adjusted= 62%.

In the full model, variables such as age, facility level, distance to facility, prescriber, days of stay in the facility, waiting time and first point of seeking treatment were included. From this model, only the variables age, medical officer prescribing and seeking treatment first from the retail shop were significant. The unadjusted R^2 was 68% and the adjusted R^2 was 62%.

Table 4: Reduced model for cost of treating paediatric malaria in Homa Bay County

Reduced Model				
Parameter	**Parameter Est. (se)**	**95% CI**	**t-Value**	**p-Value**
Age (years)	88.1 (43.3)	2.28 -173.9	2.03	**0.044**
Facility Level				
Level 3	-301.5 (333.1)	-961.5 - 358.6	0.06	0.945
Level 4	-79.6 (265.9)	-606.6 - 447.4	-0.90	0.765
Level 5	1,401.8 (543.2)	325.2 - 2,478.3	2.60	**0.011**
Days of Stay at facility	235.5 (56.8)	122.9 - 347.9	4.10	**<0.001**
Prescriber				
Medical Officer	746.6 (216.9)	316.8 - 1,176.4	2.40	**<0.001**
Nurse	318.5 (56.8)	-253.6 - 890.9	4.10	0.272

$\mathbf{R^2}$ = 64%, $\mathbf{R^{2-}}$ Adjusted= 62%

A stepwise multiple linear regression was then performed to select the variables that contribute most meaningfully to the model. After this stepwise process, the variables that were isolated as mostly contributing to the model were Age, Facility levels, Days of stay in the facility and Prescriber. However, the statistically significant variables were Age (t value = 2.03, p-value = 0.044), Facility level 5 (t value = 2.60, p-value = 0.011), Days of stay in the facility (t value = 4.10, p-value < 0.001) and Medical Officer as the prescriber (t value = 2.40, p-value < 0.001). For every additional year of age, the total cost increased by USD 0.88 (95% CI= 2.28, 173). Compared to level 2 facilities, the total cost of care was more expensive by USD 14 (95% CI= 325.2, 2478.3) in the level 5 facilities. For every additional day spent in the facility, the total cost of care increased by USD 2.35 (95% CI= 122.9, 347.9) shillings. Being prescribed medicines by a Clinical Officer led to the total cost being lower by USD. 7.5 (95% CI= 316.8, 1176.4) compared being prescribed to by a Medical Officer. The unadjusted R^2 of the reduced model was 64% and the adjusted R^2 was 62%. This means that 64% of the relationship between cost variables and total cost as captured in this model is explained by the model and not random chance. This is a significant model fit. From the variables in the reduced model, a regression equation was developed and summarized as follows;

The Multiple Linear Regression Equation

The econometric cost model for treating paediatric malaria in Homa-Bay County generated from our data was represented by the generic equation given by;

$$TC = \beta_1 \mathbf{Age} - \beta_2 \mathbf{Level\ 3} - \beta_3 \mathbf{Level\ 4} + \beta_4 \mathbf{Level\ 5} + \beta_5 \mathbf{Days\ of\ stay} + \beta_6 \mathbf{MO} + \beta_7 \mathbf{Nurse} + \mathbf{E}$$

Where

TC = Total Cost

Age = Age of the respondent

Level 3 = treated at a level 3 health facility

Level 4 = treated at a level 4 health facility

Level 5 = treated at a level 5 health facility

Days of stay = Number of days the respondent stays in the facility

MO = Prescribed medicines by a Medical officer

Nurse = Prescribed medicines by a Nurse

E = Error term

On substitution of the values of the coefficients, the final regression equation is

Total Cost = 88.1***Age** – 301.5***Level3** -779.6***Level 4** + 1401.8***Level 5** + 235.5***Days of stay** + 746.6*MO + 318.5***Nurse** + **E**

Discussion

What are our key findings?

- Despite waiver of user fees, indirect costs are still a significant barrier of access to paediatric malaria treatment.
- Opportunity cost of paediatric malaria treatment is a key cost centre for paediatric malaria treatment.

What do the new findings mean?

- There need to devise policies to minimize indirect costs of paediatric malaria treatment in rural health facilities even when user fees have been waived.

- There is need to speed up the treatment process of paediatric malaria in rural health facilities to cut on indirect costs of care.

Costing was performed by the ingredient approach with the patient perspective being adopted. The patient perspective was considered the most appropriate because the survey focused on the individual patients at the point of exiting the process of care. The median total cost was 6.5 dollars with a mean of 10 dollars and a range of USD 1.4 to 65. This was lower than those reported from a study in Zambia where the average cost was USD 32 for uncomplicated and USD 77 for severe complicated malaria [12] that those reported from an earlier Kenyan Study where the average cost was USD 96 [13]. Indirect costs were almost double the direct costs,

indicating that indirect cost of care could be a major barrier to accessing care in this rural County even though official user fees for paediatric malaria are abolished by the government. These findings concur with those from a study in Bolivia which indicated that indirect costs still impede access to paediatric care irrespective of user fee abolition [14]. The greatest proportion of the total cost was the value of time lost in the process of seeking care. Most previous studies have not incorporated this indirect cost of time lost to care seeking in their costing models. Modelling the total cost of treatment was done by multiple linear regression modelling in R software with dummy variables for age, facility level and prescriber. The variables included in the reduced model were Age, Facility levels, Days of stay in the facility and Prescriber. For every additional year of age, the total cost increased by USD 0.88 (95% CI= 0.023, 1.73). This indicated that older children bore higher costs than younger ones. Compared to level 2 facilities, the total cost of care was more expensive by USD 14 (95% CI= 325.2, 2478.3) in the level 5 facility. This increased cost in higher level hospitals is in concurrence with the findings of a study in China [15]. Level 5 facilities were centrally located in the county and had health care providers with higher academic qualifications than those in lower level facilities. Before a patient is sent to such a facility, they are likely to have gone through lower level facilities. The cases referred to it are therefore more severe or need more specialized attention than those at lower level facilities. Before a patient comes to this facility, they would have spent more transport cost since it is centrally located in the County. They would also have spent more time caring for the ill child in a lower level facility prior to referral. This may explain why the cost involved is very high compared to lower level facilities. The average number of days spent in the facility was 2 days. For every additional day spent in the facility, the total cost of care increased by USD 2.35 (95% CI= 1.23, 3.48). The number of days spent in the facility may also have been influenced by factors such the severity of illness at admission, the time taken before seeking care, quality of care and the bed capacity of the hospital [16-18]. Being prescribed medicines by a Clinical Officer led to the total cost being lower by USD 7.5 (95% CI= 3.17, 11.76) compared being prescribed to by a Medical Officer. This may be because medical doctors tend to prescribe branded medicines more than their generic versions [19]. However, in government health facilities where patients don't pay for consultation, this observation cannot be fully explained. Studies elsewhere have also reported that seeking care from medical doctors is more costly than lower cadre health care providers [20]. Medical officers were more often found in higher level

facilities which are few and centrally located hence accessing them attracted more transport and hotel costs. In many cases of paediatric malaria treatment, the main cost centres are often consultation, medicines, transport and hospitalization with the most significant being the cost of medicines [21]. In the contrary, from our findings, the greatest contributor to to the total cost of care is the opportunity cost of productive time lost while caring for the sick child.

Conclusions

The Homa-Bay County Referral Hospital is much more costly than lower level health facilities indicating that the poorest who may not afford the specialized treatment in this facility may be financially barred from paediatric malaria care in the hospital. The top two drivers of cost of paediatric malaria treatment in Homa-Bay County are being admitted to the County referral hospital and a medical officer prescribing. Efforts aiming at reducing the cost of paediatric malaria treatment therefore need to focus on availing quality treatment at lower level facilities through better staffing, performance monitoring and improved infrastructure.

Unanswered questions and future research

From our findings, one of the greatest contributors to cost of treatment is being treated by a medical officer. It is not clear why this would be so especially in public health facilities where patients don't pay directly for consultation. There is therefore need for further research in other Counties and regions to attempt to validate this finding.

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Data Sharing

The data used to support the findings of this study are available from the corresponding author upon request.

Competing Interests

The authors declare that they have no competing interests.

Author Contributions

The conceptualization and protocol development was done by all the authors. Data collection and analysis was done by MOK. MOK drafted the manuscript which was validated and corrected by JOO and BKA.

References

1. Buigut S, Ettarh R, Amendah DD.Catastrophic health expenditure and its determinants in Kenya slum communities.Int J Equity Health. 2015 May 14;14:46. doi: 10.1186/s12939-015-0168-9.

2. Ayieko P, Ogero M, Makone B, Julius T, Mbevi G, Nyachiro W, Nyamai R, Were F, Githanga D, Irimu G, English M; Clinical Information Network authors. Characteristics of admissions and variations in the use of basic investigations, treatments and outcomes in Kenyan hospitals within a new Clinical Information Network. Arch Dis Child. 2015 Dec 10. [Epub ahead of print]

3. World Health Organization (2015). World Malaria Report 2015, Geneva, World Health Organization

4. Onwujekwe O, Hanson K, Uzochukwu B, Ichoku H, Ike E, Onwughalu B. Are malaria treatment expenditures catastrophic to different socio-economic and geographic groups and how do they cope with payment? A study in southeast Nigeria.Trop Med Int Health. 2010 Jan;15(1):18-25. doi: 10.1111/j.1365-3156.2009.02418.x. Epub 2009 Nov 3.

5. Sicuri E, Vieta A, Lindner L, Constenla D, Sauboin C. The economic costs of malaria in children in three sub-Saharan countries: Ghana, Tanzania and Kenya. Malar J. 2013 Sep 3; 12:307. doi: 10.1186/1475-2875-12-307.

6. Sicuri E, Davy C, Marinelli M, Oa O, Ome M, Siba P, Conteh L, Mueller I. The economic cost to households of childhood malaria in Papua New Guinea: a focus on intra-country variation. Health Policy Plan. 2012 Jul;27(4):339-47. doi: 10.1093/heapol/czr046. Epub 2011 Jun 22.

7. Barasa E, Ayieko P, Cleary S, English M. Out-of-pocket costs for paediatric admissions in district hospitals in Kenya. Trop Med Int Health. 2012 Aug;17(8):958-61. doi: 10.1111/j.1365-3156.2012.03029. x. Epub 2012 Jun 21.

8.*http://datatopics.worldbank.org/world-development-indicators/stories/the-classification-of-countries-by-income.html* Oct 4, 2018.

9. UN Inter-agency Group for Child Mortality Estimation, 2019. Kenya Country Summary, March 2017

10. Kenya National Bureau of Statistics (KNBS). (2016). *Statistical Abstract 2015.* Nairobi: KNBS.

11. Johnston K, Lakzadeh P, Donato B, Szabo S.Methods of sample size calculation in descriptive retrospective burden of illness studies. BMC Med Res Methodol. 2019 Jan 9;19(1):9.doi: 10.1186/s12874-018-0657-9.

12. Comfort B, Janneke H, Sungano M, Stillman K, Gabert R, Korde S, Nachbar N, Derriennic Y, Musau S, Hamazakaza P, Zyambo K, Zyongwe N, Hamainza B and Thuma P. Hospitalization and costs incurred at the facility level after scale-up of malaria control; Pre- Post comparisons from two hospitals in Zambia. Am J Trop Med Hyg. 2014 Jan. 8; 90(1): 20-32.

13. Ayieko P, Okumu A, Griffith U and English M. The Economic burden of inpatient paediatric care in Kenya: household and provider costs for treatment of pneumonia, malaria and meningitis. Cost Eff Resource Alloc. 2009; 7:3

14. Burke RM, Rebolledo PA, Embrey SR, Wagner LD, Cowden CL, Kelly FM, Smith ER, Iñiguez V, Leon JS. The burden of pediatric diarrhea: a cross-sectional study of incurred costs and perceptions of cost among Bolivian families.BMC Public Health. 2013 Aug 2;13:708. doi: 10.1186/1471-2458-13-708.

15. Xia S, Ma J, Wang D, Li S, Rollinson D, Zhou X. Economic cost analysis of malaria case management at the household level during the malaria elimination phase in The People's Republic of China. Infect Dis Poverty. 2016 Jun 3;5(1):50. doi: 10.1186/s40249-016-0141-x.

16. Sicuri E, Davy C, Marinelli M, Oa O, Ome M, Siba P, Conteh L, Mueller IThe economic cost to households of childhood malaria in Papua New Guinea: a focus on intra-country variation.Health Policy Plan. 2012 Jul;27(4):339-47. doi: 10.1093/heapol/czr046. Epub 2011 Jun 22.

17. Kyaw SS, Drake T, Ruangveerayuth R, Chierakul W, White NJ, Newton PN, Lubell Y. Cost of treating inpatient falciparum malaria on the Thai-Myanmar border. Malar J. 2014 Oct 29; 13:416. doi: 10.1186/1475-2875-13-416.

18. Beogo, Huang N, Drabo MK, Yé Y. Malaria related care-seeking-behaviour and expenditures in urban settings: A household survey in Ouagadougou, Burkina Faso. Acta Trop. 2016 Aug; 160:78-85. doi: 10.1016/j.actatropica.2016.03.033. Epub 2016 May 3.

19. Adair FR, Holmgren LR. Do drug samples influence resident prescribing behavior? A randomized trial. The American Journal of Medicine Volume 118, Issue 8, August 2005, Pages 881-88

20. Soremekun S, Kasteng F, Lingam R, Vassall A, Kertho E, Settumba S, Etou PL, Nanyonjo A, Ten Asbroek G, Kallander K, Kirkwood B; inSCALE Study Group.Variation in the quality and out-of-pocket cost of treatment for childhood malaria, diarrhoea, and pneumonia: Community and facility based care in rural Uganda. PLoS One. 2018 Nov 26;13(11):e0200543. doi: 10.1371/journal.pone.0200543. eCollection 2018.

21. Nabyonga O, Mugisha F, Okui A, Musango L, Kirigia J. Health care seeking patterns and determinants of out-of-pocket expenditure for malaria for the children under-five in Uganda. Malar J. 2013 May 31; 12:175. doi: 10.1186/1475-2875-12-175.

Appendix 9: Informed Consent explanation and Consent Form for Households

TITLE OF THE STUDY: ECONOMIC AND HEALTH SYSTEMS DETERMINANTS OF ACCESS TO QUALITY TREATMENT OF PAEDIATRIC MALARIA IN HOMA-BAY COUNTY, KENYA.

Institution: University of Nairobi Institute of Tropical and Infectious Diseases

Box 30197- 00400, Nairobi**.**

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Email-makodhiambo@yahoo.com

Supervisors: Dr. Beatrice Amugune **(Cell-07228020) and** Dr. Julius Oyugi **(Cell-0713898564)**

Introduction: Permission is requested from you to enrol in this medical research study. You should understand that the general ethical principles which apply to all in medical research, whether involving well or patient volunteers will apply to this study.

Purpose of the study: The overall purpose of this study is to establish the economic and health systems determinants of access to quality treatment of paediatric malaria patients in Homa-Bay County. The specific purpose of this part of the study is to investigate household factors that influence access to quality treatment for paediatric malaria patients in Homa-Bay County

What the study entails: If you accept to take part, you will be asked some questions concerning your household and your access to quality treatment of paediatric malaria as a household. Your household has been selected because it is in the sub-location that has been selected randomly.

Potential Risks: No risks are expected from this study since all information you will provide will be handled confidentially and will be used for the purposes of this study only.

Benefits: No direct benefits will accrue to you from this study. However, it is hoped that the results of this study will be useful in improving treatment outcomes of paediatric malaria both from the policy and practice perspectives.

Voluntarism: Your agreement to enrol in this study is entirely voluntary. You may withdraw from the study at any time without necessarily giving any reason for such withdrawal. After you read the explanation, please feel free to ask any questions that will enable you to understand clearly the nature of this study before consenting.

Assurance on confidentiality: All information you provide will be kept confidential and used for the purposes of this study only. Your name will not be used during data handling or in any resulting publications. Codes will be used instead.

Contacts: In case you need to contact me, my supervisors or my academic department, and more importantly the ethical committee, that has approved this study, for further information concerning this study, please feel free to use the given contacts.

Informed Consent Form

Researcher Declaration: I hereby confirm that I have exhaustively explained the study to the participant and sought voluntary informed consent from her/him

Sign.....Date.....

Participant declaration: I, the undersigned, willingly agree to participate in this study, the nature and purpose of which have been fully explained to me by the investigator/translator. I understand that the information gathered will be used for the purposes of this study only and maximum confidentiality will be maintained.

Sign/Thumb print.....Date.....

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Secretary, KNH/UoN ERC (**Prof. Chindia**) - P. O. Box 19676-00202, Nairobi, Tel. (254-020) 2726300-9 Ext 44102: E-mail: uonknh_erc@uonbi.ac.ke

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	There were no missing data
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	4
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7

		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-9
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

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Modeling the Household cost of Paediatric Malaria Treatment in a Rural County in Kenya; Do non-user fee payments matter? A partial cost of illness analysis

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Modeling the Household cost of Paediatric Malaria Treatment in a Rural County in Kenya; Do non-user fee payments matter? A partial cost of illness analysis

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ABSTRACT

Objective: The objective of this study was to develop an econometric model for the cost of treatment of paediatric malaria from a patient perspective in a resource scarce rural setting of Homa-Bay County, Kenya. We sought to investigate the main contributors and the contribution of non-user fee payments to the total household cost of care. Costs were measured from a patient perspective.

Design: A health facility based cross sectional survey targeting paediatric patients.

Setting: The study was conducted in 13 health facilities ranging from level II to level V in Homa Bay County which is in the Eastern shores of Lake Victoria, Kenya. This is in a malaria area …

Participants: The study enrolled 254 inpatient children (139 males and 115 females) all of who participated up to the end of this study.

Primary outcome measure: The primary outcome measure was the cost of care for pediatric malaria borne by the patient. This was measured by asking caregivers to estimate the cost of various items forming their total expenditure on care seeking from an exit interview.

Results: A total of 254 respondents who consented from 13 public government health facilities were interviewed. Age, number of days spent at the health facility, being treated at a level V facility, medical officer prescribing and seeking initial treatment from a retail shop were found significant predictors of cost.

Conclusion Higher level health facilities in Homa-Bay County, where the more specialized medical workers are stationed, are more costly hence barring the poorest from obtaining quality paediatric malaria care from here. . Waiving user fees alone may not be sufficient to guarantee access to care by patients due to unofficial fees and non user fees expenditures..

Keywords: Modeling, Household Cost of treatment, Paediatric malaria, Homa-Bay County

Strengths and limitations of this study

Strengths

This study was conducted only four years after implementation of a devolved health care system in Kenya. This study is therefore part of an early attempt to evaluate the health systems performance post devolution. This gives it novelty.

Many previous malaria costing studies have focused on either direct costs only or costs by adult patients only. This study includes both direct and indirect costs from a patient perspective including opportunity cost of time lost for caring for the patient.

Robust statistical analysis using stepwise regression analysis was thereby chosen to take care of any possible confounders to the study findings.

Limitations

The data was collected solely through exit interviews for caregivers. This may weaken validity of the findings as some respondents may have been fatigued by the stay in the hospital.

The study was conducted in one county and the findings may therefore not be generalizable to all counties in Kenya due to geographic and socioeconomic variation across the board. .

INTRODUCTION

Cost of health care services in sub-Saharan Africa is a major impediment to attainment of Universal Health Coverage [1]. Malaria is a major cause of paediatric morbidity and mortality in this part of the world [2,3]. The burden of malaria treatment on households is felt most among poor rural populations [4]. Understanding the cost drivers for the treatment of paediatric malaria is important for devising strategies for optimizing such costs. Few cost modeling studies for malaria treatment from a patient perspective have been specifically focused on children in resource scarce settings as is the case in this study. Most models have not included costs ingredients such as forgone earnings and cost of transportation to and from the heath facility [5]. When free treatment policy for malaria in children under the age of 5 years was enforced in Kenya in 2005, it was expected that such a shift would improve financial access to treatment to the most needy of patients. This assumption however did not include non-user fee payments and other intangible costs that other studies have shown to be significantly associated with the risk of catastrophic household health expenditure [6]. There have however been reports of several unofficial user fees being charged for paediatric malaria treatment despite their official abolition [7]. This necessitates costing malaria treatment from a patient perspective in order to capture all

costs incurred by the patient in the process of care seeking. The objective of this study was to develop a cost model for the treatment of paediatric malaria from a patient perspective in the resource scarce setting of Homa-Bay County, Kenya.

METHODS

Study setting

Kenya is classified by the World Bank as a lower middle income country [8] with the under-five mortality rate at 45.6 per 1000 live births (9). Homa-Bay is a rural county with a predominantly peasant economy with poverty levels above the national average and some of the poorest child health indicators in the Kenya. In 2016, the under-five mortality was 130 per 1000 live births (10). The Kenya Demographic and Health Survey (KDHS) 2014 also indicates that most residents of Homa-Bay County lie in the lowest wealth quintile with an unfavourable Gini coefficient. These are economic indicators that may demonstrate that the average income of the residents is low. The County is located in the Eastern shores of Lake Victoria hence has climatic conditions that favour malaria endemicity, with pregnant women and children bearing the greatest burden of the disease. The prevalence of malaria in Homa bay as of 2016 was 58,820 per 100000 persons, which is more than double the national prevalence of 20,252 per 100,000 persons (10). Malaria incidence usually peaks in Kenya around September to October rainy season which coincides with the time the study was conducted.

Study design

The study was conducted as a cross sectional survey. This design was considered appropriate since it is strategic and affordable to collect all the data from the patients in one encounter at the end of the treatment process. Both the exposures and outcome were examined at the same time.

Costing Approach

Costing was conducted from a patient perspective. The total costs were summed up from component expenditures per category reported to be incurred by the patient in the process of procuring care for the child with malaria. In this study, the costing was computed to include all

user fees and non-user fee monetary expenditures incurred by the caregiver in the process of seeking care for the sick child.

Target population

The target population comprised all children below 13 years exiting government health facilities in Homa Bay County after treatment of for malaria during the period of study. Children below the age of 13 years were targeted because they tend to depend wholly on parental or guardian decisions as they are not yet financially or socially independent.

Sampling

The sample size was based on the Melody study [11] which recommends that for cost outcomes, a sample size of approximately 200 would be required to generate a 95% CI precise to within ±10% of the mean. A multistage sampling approach was adopted. First, the county was divided into eight zones based on the eight sub-counties. The health facilities were then stratified based on service provision levels (level II to level V, Table 1). The County had no level I and V facility and only one level V facility at the time of data collection. The level five facility was purposively included in the sample. Therefore, actual facility sampling was done only for levels II, III, IV and V facilities. A total of 13 facilities were sampled as shown in Table 2. From each facility, approximately 20 in-patients were sampled using the systematic random sampling approach where every other paediatric patient exiting after treatment for malaria was approached by the research assistant for recruitment. This process was repeated on daily basis until the targeted sample size of 254 participants was met.

Table 1: Classification of Health facilities based on service level

Facility level	Basis	Services offered include
Level I	Community	A range of preventive and curative services with a focus on primary care services.
Level II	Dispensaries	Management of common illnesses in the specific region
Level III	Health centers	Formal immunization programs, HIV testing and referral
Level IV	District referral hospitals	Antenatal care (ANC) and routine birthing services, HIV/AIDS care (96%), paediatric services (93%), and emergency obstetric care (EmOC) (78%).
Level V	Provincial referral hospitals	Surgical services, internal medicine, and specialty

		services such as emergency EmOC and anesthesiology but less extensive as the National Referral Hospitals.
Level VI	National referral hospitals	Surgical services, internal medicine, and specialty services such as EmOC and anesthesiology

Source: Ministry of Health, 2017: The Health care system in Kenya and Kenyan healthcare sector: market study report

Table 2: Number of health facilities and participants sampled in the study

Facility level	II	III	IV	V	**Total**
Number of facilities	13	9	12	1	**35**
Number of facilities sampled	4	3	5	1	**13**
Number of in-patients sampled	68	54	100	32	**254**

Recruitment of study participants

A research assistant approached a caregiver of an in-patient who had just been treated for malaria at the time of exit. This was followed by self introduction after which the caregiver was requested to read the consent explanation (in a language they best understood- English, Swahili or Luo) and consider consenting.

Data collection

Data on contributors to cost as well as cost of paediatric malaria was collected from August 2016 to November 2016 by use of a structured exit interview guide on consented participants. This period was selected because malaria infections in the region usually peak during rainy seasons of September to October. Both direct costs such as out of pocket payments and cost of medicines purchased as well as indirect costs such as transport, food, waiting time and opportunity cost incurred while taking care of the sick child were measured in Kenya shillings but reported in USD (100 Kshs= 1 USD) .

The interviewers were trained to probe opportunity cost borne by caregivers in the process of seeking health care for the sick child by asking them to state their occupation. From this, the

approximate forgone benefit was estimated to triangulate the information gathered from their response to the direct questions posed to the caregiver about their estimated opportunity cost.

Quality assurance

Data collectors were trained for two days on the survey tool as well as the procedure in a classroom setting and then practised in the pre-test health facility outside the data collection area (Migori County). Data collection instruments were examined by supervisors and other experts to ascertain their quality and validity.

Data analysis

Data was checked for completeness, cleaned, sorted and coded. This was followed by data entry into excel (2016) spreadsheet in readiness for analysis by use of the R statistical software to compute descriptive statistics on cost of treatment. The cost of treatment was then further modeled on R (Studio) statistical package using a stepwise multiple linear regression approach.

Ethical Considerations

All principles pertaining ethical conduct of research with human subjects were adhered to in this study as embodied in the Declaration of Helsinki. Ethical approval was obtained from the Kenyatta National Hospital/University of Nairobi-Ethics and Review Committee (KNH-UON ERC Ref-**P389/05/2016**).

Patient and Public Involvement

Given that was no funding for this study, there were no funds or time allocated for patient or public involvement so we were unable to involve patients. However, we plan to invite representatives of the public to help us write a plain language summary for further dissemination of the results.

RESULTS

The survey was conducted across various health facilities ranging from level II to level V. Most of the participating children, 47.6% (121), had been treated in level IV facilities. Level II facilities had 26.8% (68) of the children, level III, 21.3% (54) and level V, 4.3% (11). Most

participants, 55.5% (141), were 4-6 years old. Male children were 54.7% (139) while females were 45.3% (115). Most of the participants, 62.6% (159), travelled for 2 to 5 km to reach the health facility using mainly a motorcycle as the preferred means of transport 66.1% (168). After reaching the hospital, most of them, 72% (183), waited for about one hour to be served while 18.1%(46) were attended to within 30 minutes. Medical officers, 46.5% (118) were the most common prescribers followed by clinical officers at 35.8% (91). Nurses prescribed for 17.7% (45) of the respondents. Most caregiver-respondents, 70% (178), stayed in the hospital with their children for two days or less with most of them, 61.8% (157), describing the condition of their children at admission as not very sick. Most of the participants 48 %(122) first sought medical care in a community pharmacy outlet before proceeding to a government health facility. Table 3 is a summary of the baseline characteristics of the study participants.

Table 3: Sociodemographic characteristics of study participants

Factor	Number of children	%
Facility Level		
Level I	68	26.8
Level III	54	21.3
Level IV	121	47.3
Level V	11	4.4
Age of child		
< 1	11	4.3
1 – 3	74	29.1
4 – 6	141	55.5
7 – 9	22	8.7
10 +	6	2.4
Sex of child		
Male	139	54.7
Female	115	45.3
Distance to health facility (Km)		
< 1	40	15.7
2 – 5	159	62.6

5 – 10	50	19.7
> 10	5	2.0
Mode of Transport to health facility		
Ambulance	2	0.8
Bicycle	13	5.1
Motorcycle	168	66.1
On Foot	55	21.7
Private Vehicle	4	1.6
Public Service Vehicle	12	4.7
Waiting Time before initial treatment		
< 30 Minutes	46	18.1
1 hr	183	72.0
2 hrs	10	3.9
3 hrs	7	2.8
3 + hrs	8	3.2
Prescriber		
Clinical Officer	91	35.8
Medical Officer	118	46.5
Nurse	45	17.7
Days of Stay at the facility		
1 – 2	178	70.0
3 – 4	38	15.0
5 – 7	38	15.0
Caregiver reported severity of Illness at admission		
Not Very Sick	157	61.8
Very Sick	97	38.2
Initial treatment site		
Community Pharmacy outlet	122	48.0
Dispensary (Level II)	39	15.4
Government Hospital	36	14.2
Private Hospital	36	14.2
Religious Leader	16	6.3
Retail Shop	5	2.0

Cost drivers for the treatment of paediatric malaria in Homa-Bay County

The individual patient reported costs per category were analyzed and summarized as in Table 4.

Table 4: Patient reported costs of treating paediatric malaria in Homa-Bay County

	Cost of Treatment(USD)

	Mean	Median	Minimum	Maximum
Transport	0.81	0.50	0	20
Food	2.29	2.00	0.20	18
Value of time used for seeking care	5.56	3.25	1	50
Direct Payment	1.38	12	0	50

Modeling the cost of treating paediatric malaria

The model representing the cost of treating paediatric malaria in Homa-Bay County was developed by use of stepwise multiple linear regression analysis of the costing data collected from the exit interviews. The full model was first formulated as shown in Table 5 followed by a reduced model **after Bootstrapping regression** shown in Table 6.

Table 5: Full Model of the cost of treatment of paediatric malaria

Full model				
Full model				
Parameter	**Parameter Esti. (se)**	**95% CI**	**t-Value**	**p-Value**
		LB – UB		
Age	0,85 (0.42)	0.20-1.59	2.00	**0.047**
Facility Level				
Level II	1			
Level III	0.27 (4.08)	-9.04– 8.40	0.06	0.945
Level IV	2.20 (3.52)	-6.54– 8.84	0.63	0.533
Level V	7.39 (7.39)	-8.74 - 20.94	1.00	0.319
Distance to Facility				
1 – 2 days	1			
3 – 5	-3.87 (2.64)	-8.83– 2.26	-1.5	0.144
6 – 10	3.89 (3.53)	-8.74 – 5.93	-1.1	0.273
10 +	4.14 (6.20)	-12.31 - 12.30	0.7	0.506
Prescriber				
Clinical Officer	1			
Medical Officer	6.01(2.55)	0.92 - 11.50	2.40	**0.021**
Nurse	4.91(2.99)	-32.37 – 9.06	1.60	0.104
Days of Stay	2.11 (0.63)	0.86 – 3.35	0.94	**0.001**
Waiting Time				

<30 minutes	1			
Within 1 hr	3.03 (2.38)	-2.25 – 7.77	1.30	0.206
Within 2 hrs	3.95 (4.60)	-6.73 - 12.43	0.90	0.392
Within 3 hrs	2.75 (5.15)	-8.85 – 8.13	0.50	0.594
Initial Treatment site				
Community Pharmacy outlet	1			
Dispensary	1.59(4.05)	-8.85 – 8.13	0.40	0.696
Government Hosp	9.59 (8.15)	-5.95 - 26.12	1.20	0.242
Private Hosp	0.09 (2.91)	-4.59 – 6.86	0.03	0.976
Religious Leader	4.20 (3.02)	-0.39 - 12.23	1.40	0.168
Retail Shop	14.40 (6.84)	1.19 - 29.43	2.10	**0.038**

R2 = 68%, R2- Adjusted= 62%.

Table 6: Reduced model for cost of treating paediatric malaria in Homa Bay County

Reduced Model – After Bootstrapping Regression				
Parameter	**Parameter Est. (se)**	**95% CI**	**t-Value**	**p-Value**
Age (years)	0.83 (0.45)	-0.05-1.71	1.8	0.066
Facility Level				
Level II	1			
Level III	3.36 (3.19)	-2.97-9.69	1.1	0.294
Level IV	5.87 (2.61)	0.70-11.04	2.3	**0.026**
Level V	20.64 (5.13)	10.49-30.83	4.0	**<0.001**
Days of Stay at facility	2.38 (0.58)	1.23- 3.53	4.1	**<0.001**
Prescriber				
Clinical Officer	1			
Medical Officer	6.98 (4.29)	-1.51-15.47	2.40	0.106
Nurse	2.73 (4.63)	6.44-11.90	0.59	0.556

$\mathbf{R^2}$ = 38%, $\mathbf{R^{2-}}$ Adjusted= 33%

A stepwise multiple linear regression was then performed to select the variables that contribute most meaningfully to the model. After this stepwise process, the variables that were isolated as mostly contributing to the model were age, facility levels, days of stay in the facility and prescriber. However, the statistically significant variables were days of stay in the facility (t value = 4.10, p-value < 0.001) and Level IV & V (t value = 2.3, p-value < 0.05).

From the obtained model, for every additional year of age, the total cost increased by USD 0.82 (95% CI= -0.05 – 1.71). Compared to level II facilities, the total cost of care was more expensive by USD 14 (95% CI= 3.25, 24.78) in the level V facilities. For every additional day spent in the facility, the total cost of care increased by USD 2.35 (95% CI= 1.23, 3.48) shillings. Being prescribed medicines by a Clinical Officer led to the total cost being lower by USD. 7.5 (95% CI= 3.17, 11.76) compared to prescription by a Medical Officer. The unadjusted coefficient of determination, R^2, of the reduced model was 38% and the adjusted R^2 was 33%. This means that 33% of the relationship between cost variables and total cost as captured in this model is explained by the model and not random chance. This model thus explains 33% of the variation in costs. From the variables in the reduced model, a regression equation was developed and summarized as follows;

The Multiple Linear Regression Equation

The econometric cost model for treating paediatric malaria in Homa-Bay County generated from our data was represented by the generic equation given by;

TC = β1 **Age** - β2 **Level 3** - β3 **Level 4** + β4 **Level 5** + β5 **Days of stay** + β6 **MO** + β7 **Nurse** + **€**

Where

TC = Total Cost

Level 3 = treated at a level 3 health facility

Level 4 = treated at a level 4 health facility

Level 5 = treated at a level 5 health facility

Days of stay = Number of days the respondent stays in the facility

€ = Error term

On substitution of the values of the coefficients, the final regression equation is

Total Household Cost = 3.36***Level III** +5.87***Level IV** + 20.63***Level V** + 23.83***Days of stay** +6.98*Medical Officer +2.73*Nurse + **€**

Discussion

Costing was performed from a patient perspective. The patient perspective was considered the most appropriate because the survey focused on the individual patients at the point of exiting the process of care. The median total cost (USD) was 6.5 with a mean of 10 and a range of 1.4 to 65. This was lower than those reported from a study in Zambia where the average cost was 32

for uncomplicated and USD 77 for severe complicated malaria [12] and from an earlier Kenyan Study with an average cost of USD 96 [13].

Non-user fees such as cost of transportation and food were almost double the user fees, indicating that such costs of care could be a major barrier to accessing care in this rural County even though official user fees for paediatric malaria are abolished by the government. It also shows that some facilities still charge unofficial user fees thus increasing the barrier to access. These findings concur with those from a study in Bolivia which indicated that indirect costs still impede access to paediatric care irrespective of user fee abolition [14].

One of the main contributors to total household costs was the value of time lost in the process of seeking care. Most previous studies have not incorporated the cost of time lost due to care seeking in their costing models.

Compared to level II facilities, the total cost of care was more expensive by USD 14 (95% CI= 3.25, 24.78) in the level V facility. This increased total cost in higher level hospitals is in concurrence with the findings of a study in China [15]. Level V facility was centrally located in the county and had health care providers with higher academic qualifications than those in lower level facilities. Before a patient is sent to such a facility, they are likely to have gone through lower level facilities. The cases referred to it are therefore more severe or need more specialized attention than those at lower level facilities. Similarly, before a patient comes to the higher level facility, they would have spent more on transport cost since it is centrally located in the County. They would also have spent more time caring for the ill child at the lower level facility prior to referral higher level. This may explain why the cost involved is at higher level facilities is higher compared to lower level facilities.

The average number of days spent in the facility was 2 days. For every additional day spent in the facility, the total cost of care increased by USD 2.35 (95% CI= 1.23, 3.48). The number of days spent in the facility may also have been influenced by factors such the severity of illness at admission, the time taken before seeking care, quality of care and the bed capacity of the hospital [16,17].

Being prescribed medicines by a Clinical Officer led to the total cost being lower by USD 7.5 (95% CI= 3.17, 11.76) compared being prescribed to by a Medical Officer. This may be because medical doctors tend to prescribe branded medicines more than their generic versions [18]. However, in government health facilities where patients don't pay for consultation, this observation cannot be fully explained. Studies elsewhere have also reported that seeking care from medical doctors is more costly than lower cadre health care providers [19]. Medical officers were more often found in higher level facilities which are few and centrally located hence accessing them attracted more transport and hotel costs. In many cases of paediatric malaria treatment, the main cost centres are often consultation, medicines, transport and hospitalization with the most significant being the cost of medicines [20]. In the contrary, from our findings, the greatest contributor to the total cost of care is the opportunity cost of productive time lost while caring for the sick child.

Conclusion

The Homa-Bay County Referral Hospital (level V) is much more costly than the other lower level health facilities in the county indicating that the poorest who may not afford or access the specialized treatment offered thus may be financially barred from obtaining the superior paediatric malaria care. The top two drivers of patient borne cost of paediatric malaria treatment in Homa-Bay County are being admitted at the County referral hospital and a medical officer prescribing the medication. Efforts aiming at reducing the cost of paediatric malaria treatment therefore need to focus on availing quality treatment at the lower level facilities through better trained and experienced staffing, performance monitoring and improved infrastructure.

Unanswered questions and future research

From our findings, one of the greatest contributors to cost of treatment is being treated by a medical officer. It is not clear why this would be so especially in public health facilities where patients don't pay directly for consultation. This could be some form of indictment on the training and experience as well as training on treatment guidelines of medical staff in public

service. There is therefore need for further research in other Counties and regions to attempt to validate this finding.

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Data Sharing

Data are available upon reasonable request. The data is deidentified participant data and is available from the corresponding author of email address; kodhiambo.maurice@ ku.ac.ke. Additional information available is the study protocol as approved the ethics committee.

Competing Interests

The authors declare that they have no competing interests.

Author Contributions

The conceptualization and protocol development was done by all the authors. Data collection and analysis was done by MOK. MOK drafted the manuscript which was validated and edited by JOO and BKA. All authors gave final approval of the version to be published. All authors declare neither financial nor personal relationship conflict of interest. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Buigut S, Ettarh R, Amendah DD.Catastrophic health expenditure and its determinants in Kenya slum communities.Int J Equity Health. 2015 May 14;14:46. doi: 10.1186/s12939-015-0168-9.

2. Ayieko P, Ogero M, Makone B, Julius T, Mbevi G, Nyachiro W, Nyamai R, Were F, Githanga D, Irimu G, English M; Clinical Information Network authors. Characteristics of admissions and variations in the use of basic investigations, treatments and outcomes in Kenyan hospitals within a new Clinical Information Network. Arch Dis Child. 2015 Dec 10. [Epub ahead of print] 3. World Health Organization (2015). World Malaria Report 2015, Geneva, World Health Organization

4. Onwujekwe O, Hanson K, Uzochukwu B, Ichoku H, Ike E, Onwughalu B. Are malaria treatment expenditures catastrophic to different socio-economic and geographic groups and how do they cope with payment? A study in southeast Nigeria.Trop Med Int Health. 2010 Jan;15(1):18-25. doi: 10.1111/j.1365-3156.2009.02418.x. Epub 2009 Nov 3.

5. Sicuri E, Vieta A, Lindner L, Constenla D, Sauboin C. The economic costs of malaria in children in three sub-Saharan countries: Ghana, Tanzania and Kenya. Malar J. 2013 Sep 3; 12:307. doi: 10.1186/1475-2875-12-307.

6. **Sicuri** E, Davy C, Marinelli M, Oa O, Ome M, Siba P, Conteh L, Mueller I. The economic cost to households of childhood malaria in Papua New Guinea: a focus on intra-country variation. Health Policy Plan. 2012 Jul;27(4):339-47. doi: 10.1093/heapol/czr046. Epub 2011 Jun 22.

7. Barasa E, Ayieko P, Cleary S, English M. Out-of-pocket costs for paediatric admissions in district hospitals in Kenya. Trop Med Int Health. 2012 Aug;17(8):958-61. doi: 10.1111/j.1365-3156.2012.03029. x. Epub 2012 Jun 21. Page 15 of 105

8. *http://datatopics.worldbank.org/world-development-indicators/stories/the-classification-fcountries-by-income.html* Oct 4, 2018

9. UN Inter-agency Group for Child Mortality Estimation, 2019. Kenya Country Summary, March 2017

10. Kenya National Bureau of Statistics (KNBS). (2016).*Statistical Abstract 2015.* Nairobi: KNBS.

11. Johnston K, Lakzadeh P, Donato B, Szabo S. Methods of sample size calculation in descriptive retrospective burden of illness studies. BMC Med Res Methodol. 2019 Jan 9;19(1):9.doi: 10.1186/s12874-018-0657-9.

12. Comfort B, Janneke H, Sungano M, Stillman K, Gabert R, Korde S, Nachbar N, Derriennic Y, Musau S, Hamazakaza P, Zyambo K, Zyongwe N, Hamainza B and Thuma P. Hospitalization and costs incurred at the facility level after scale-up of malaria control; Pre- Post comparisons from two hospitals in Zambia. Am J Trop Med Hyg. 2014 Jan. 8; 90(1): 20-32.

13. Ayieko P, Okumu A, Griffith U and English M. The Economic burden of inpatient paediatric care in Kenya: household and provider costs for treatment of pneumonia, malaria and meningitis. Cost Eff Resource Alloc. 2009; 7:3

14. Burke RM, Rebolledo PA, Embrey SR, Wagner LD, Cowden CL, Kelly FM, Smith ER, Iñiguez V, Leon JS. The burden of pediatric diarrhea: a cross-sectional study of incurred costs and perceptions of cost among Bolivian families.BMC Public Health. 2013 Aug 2; 13:708. doi: 10.1186/1471-2458-13-708.

15. Xia S, Ma J, Wang D, Li S, Rollinson D, Zhou X. Economic cost analysis of malaria case management at the household level during the malaria elimination phase in The People's Republic of China. Infect Dis Poverty. 2016 Jun 3;5(1):50. doi: 10.1186/s40249-016-0141-x.

22.

16. **Kyaw** SS, Drake T, Ruangveerayuth R, Chierakul W, White NJ, Newton PN, Lubell Y. Cost of treating inpatient falciparum malaria on the Thai-Myanmar border. Malar J. 2014 Oct 29; 13:416. doi: 10.1186/1475-2875-13-416. Page 16 of 105

17. Beogo, Huang N, Drabo MK, Yé Y. Malaria related care-seeking-behaviour and expenditures in urban settings: A household survey in Ouagadougou, Burkina Faso. Acta Trop. 2016 Aug; 160:78-85. doi: 10.1016/j.actatropica.2016.03.033. Epub 2016 May 3.

18. Adair FR, Holmgren LR. Do drug samples influence resident prescribing behavior? A randomized trial. The American Journal of Medicine Volume 118, Issue 8, August 2005, Pages 881-88

19. Soremekun S, Kasteng F, Lingam R, Vassall A, Kertho E, Settumba S, Etou PL, Nanyonjo A, Ten Asbroek G, Kallander K, Kirkwood B; inSCALE Study Group.Variation in the quality and out-of-pocket cost of treatment for childhood malaria, diarrhoea, and pneumonia: Community and facility based care in rural Uganda. PLoS One. 2018 Nov 26;13(11):e0200543. doi: 10.1371/journal.pone.0200543. eCollection 2018.

20. Nabyonga O, Mugisha F, Okui A, Musango L, Kirigia J. Health care seeking patterns and determinants of out-of-pocket expenditure for malaria for the children under-five in Uganda. Malar J. 2013 May 31; 12:175. doi: 10.1186/1475-2875-12-175.

CHEERS checklist—Items to include when reporting economic evaluations of health interventions

Section/item	Item No	Recommendation	Reported on page No/ line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as "cost-effectiveness analysis", and describe the interventions compared.	page 1, line 2
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	page 2, line 10 to 33
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study.	page 2, line 16 to 30
		Present the study question and its relevance for health policy or practice decisions.	page 2, line 34 to 36
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	page 4, line 7 to 12;
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	page 3, line 10 to 24
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	page 1, line 12; page 4, line1;
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	Not applicable since this was simply a cost analysis
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	Not applicable since this was simply a cost analysis
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	Not applicable since this was simply a cost analysis
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	Not applicable since this was simply a cost analysis
Measurement of effectiveness	11a	*Single study-based estimates:* Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	Not applicable since this was simply a cost analysis
	11b	*Synthesis-based estimates*: Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	Not applicable since this was simply a cost analysis
Estimating resources and costs	13a	*Single study-based economic evaluation:*Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	
	13b	*Model-based economic evaluation:* Describe	page 6, line 2 to

Section/item	Item No	Recommendation	Reported on page No/ line No
		approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	page 6.
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	page 6, table 7 to 9;
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	page 6, line 23 to 25;
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	Assumption of linearity was made
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	page 6, line 23 to 25;
Results			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	page 7, line1 to 15; page 7, Table 3; page 9, Table 4; page 10, table 5; page 11, table 6; page 11, line 19 to page 12 line 2; page 12, line 3 to 16;
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Not Applicable
Characterising uncertainty	20a	*Single study-based economic evaluation:* Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	
	20b	*Model-based economic evaluation:* Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Not applicable
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	not applicable
Discussion			
Study findings, limitations,	22	Summarise key study findings and describe how they	page 12, line 13 to

Section/item	Item No	Recommendation	Reported on page No/ line No
generalisability, and current knowledge		support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	page 14, line 3
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	Information provided via the submission system
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	Information provided via the submission system

For consistency, the CHEERS statement checklist format is based on the format of the CONSORT statement checklist

BMJ Open

Modeling the Household cost of Paediatric Malaria Treatment in a Rural County in Kenya; Do non-user fee payments matter? A partial cost of illness analysis

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Keywords:	Community child health < PAEDIATRICS, HEALTH ECONOMICS, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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Modeling the Household cost of Paediatric Malaria Treatment in a Rural County in Kenya; do non-user fee payments matter? A partial cost of illness analysis

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ABSTRACT

Objective: The objective of this study was to develop an econometric model for the cost of treatment of paediatric malaria from a patient perspective in a resource scarce rural setting of Homa-Bay County, Kenya. We sought to investigate the main contributors as well as the contribution of non-user fee payments to the total household cost of care. Costs were measured from a patient perspective.

Design: The study was conducted as a health facility based cross sectional survey targeting paediatric patients.

Setting: The study was conducted in 13 health facilities ranging from level II to level V in Homa Bay County which is in the Eastern shores of Lake Victoria, Kenya. This is a malaria endemic area.

Participants: We enrolled 254 inpatient children (139 males and 115 females) all of whom participated up to the end of this study.

Primary outcome measure: The primary outcome measure was the cost of pediatric malaria care borne by the patient. This was measured by asking exiting caregivers to estimate the cost of various items contributing to their total expenditure on care seeking.

Results: A total of 254 respondents who consented from 13 public government health facilities were interviewed. Age, number of days spent at the health facility, being treated at a level V facility, medical officer prescribing and seeking initial treatment from a retail shop were found significant predictors of cost.

Conclusion Higher level health facilities in Homa-Bay County, where the more specialized medical workers are stationed, are more costly hence barring the poorest from obtaining quality paediatric malaria care from here. . Waiving user fees alone may not be sufficient to guarantee access to care by patients due to unofficial fees and non user fees expenditures..

Keywords: Modeling, Household Cost of treatment, Paediatric malaria, Homa-Bay County

Strengths and limitations of this study

Strengths

- The study includes both direct and indirect costs including opportunity cost of time lost for caring for the patient.
- We used robust statistical analysis; stepwise regression analysis was chosen to take care of any possible confounders to the study findings.

Limitations

- The study was conducted from a patient perspective thus restricting interpretation of the findings to the patient perspective only.
- The data was collected solely through exit interviews of caregivers.
- The study was conducted in one county and the findings may therefore not be generalizable to all counties in Kenya due to geographic and socioeconomic variations.

INTRODUCTION

Cost of health care services in sub-Saharan Africa is a major impediment to attainment of Universal Health Coverage [1]. Malaria is a major cause of paediatric morbidity and mortality in this part of the world [2,3]. The burden of malaria treatment on households is felt most among poor rural populations [4]. Understanding the cost drivers for the treatment of paediatric malaria is important for devising strategies for optimizing such costs. Few cost modeling studies on paediatric malaria treatment in resource scarce settings, from a patient perspective, have been performed as is the case in this study. Most models have not included costs ingredients such as forgone earnings and cost of transportation to and from the heath facility [5]. When free treatment policy for malaria in children under the age of 5 years was introduced in Kenya in the year 2005, it was expected that such a shift would improve financial access to treatment by the poorest patients. This assumption however did not include non-user fee payments and other intangible costs that have been shown to be significantly associated with the risk of catastrophic household health expenditure [6]. There have however been reports of several unofficial user fees being charged for paediatric malaria treatment despite their official abolition [7]. This necessitates costing malaria treatment from a patient perspective in order to capture all costs incurred by the patient in the process of care seeking. The objective of this study was to develop a cost model for the treatment of paediatric malaria from a patient perspective in the resource scarce setting of Homa-Bay County, Kenya.

METHODS

Study setting

Kenya is classified by the World Bank as a lower middle income country [8] with the under-five mortality rate at 45.6 per 1000 live births [9]. Homa-Bay is a rural County with a predominantly peasant economy with poverty levels above the national average and some of the poorest child health indicators in the Kenya. In 2016, the County under-five mortality was 130 per 1000 live births [10]. The Kenya Demographic and Health Survey (KDHS) 2014 also indicated that most residents of Homa-Bay County lie in the lowest wealth quintile with an unfavourable Gini coefficient. These are economic indicators that may demonstrate that the average income of the residents is low. The County is located in the Eastern shores of Lake Victoria hence has climatic conditions that favour malaria endemicity, with pregnant women and children bearing the greatest burden of the disease. The prevalence of malaria in Homa-Bay County, as of 2016, was 58,820 per 100000 persons, which was more than double the national prevalence of 20,252 per 100,000 persons at that time (10). Malaria incidence usually peaks in Kenya around September to October rainy season which coincides with the time the study was conducted.

Study design

The study was conducted as a cross sectional survey. This design was considered appropriate since it was strategic and affordable to collect all the data from the patients in one encounter at the end of the treatment process. Both the exposures and outcome were examined at the same time.

Costing Approach

Costing was conducted from a patient perspective. The total costs were summed up from component expenditures incurred per category in the process of procuring care for the child with malaria as reported by the caregiver. In this study, the costing was computed to include all user fees and non-user fee monetary expenditures incurred by the caregiver in the process of seeking care for the sick child.

Target population

The target population comprised all children below 13 years exiting government health facilities in Homa-Bay County after treatment for malaria during the period of study. Children below the age of 13 years were targeted because they tend to depend wholly on their parents or guardians for health seeking decisions since they are not yet independent financially or socially.

Sampling

The sample size was based on the Melody study [11] which recommends that for cost outcomes, a sample size of approximately 200 would be required to generate a 95% CI precise to within ±10% of the mean. A multistage sampling approach was adopted. First, the County was divided into eight zones; the eight sub-counties. The health facilities were then stratified based on service provision levels (level II to level V, Table 1). The County had neither a level I nor a VI facility and only one level V facility at the time of data collection. The level five facility was purposively included in the sample. Therefore, actual facility sampling was done only for levels II, III and IV facilities. A total of 13 facilities were sampled as shown in Table 2. From each facility, approximately 20 in-patients were sampled using the systematic random sampling approach where every other paediatric patient exiting after treatment for malaria was approached by the research assistant for recruitment. This process was repeated on daily basis until the targeted sample size of 254 participants was met.

Table 1: Classification of Health facilities based on service level

Facility level	Basis	Services offered
Level I	Community	A range of preventive and curative services with a focus on primary care services.
Level II	Dispensaries	Management of common illnesses in the specific region
Level III	Health centers	Formal immunization programs, HIV testing and referral
Level IV	District referral hospitals	Antenatal care (ANC) and routine birthing services, HIV/AIDS care (96%), paediatric services (93%), and emergency obstetric care (EmOC) (78%).
Level V	Provincial referral hospitals	Surgical services, internal medicine, and specialty services such as emergency EmOC and anesthesiology but less extensive as the National Referral Hospitals.
Level VI	National referral hospitals	Surgical services, internal medicine, and specialty services such as EmOC and anesthesiology

Source: Ministry of Health, 2017: The Health care system in Kenya and Kenyan healthcare sector: market study report

Table 2: Number of health facilities and participants sampled in the study

Facility level	II	III	IV	V	Total
Number of facilities	13	9	12	1	**35**
Number of facilities sampled	4	3	5	1	**13**
Number of in-patients sampled	68	54	100	32	**254**

Recruitment of study participants

A research assistant approached a caregiver of an in-patient who had just been treated for malaria at the time of exit. This was followed by self introduction after which the caregiver was requested to read the consent explanation (in a language they best understood- English, Swahili or Luo) and consider consenting.

Data collection

Data on contributors to cost as well as cost of paediatric malaria treatment was collected from August 2016 to November 2016 by use of a structured exit interview guide on consented participants. This period was selected because malaria infections in the region usually peak during rainy seasons of September to October. Both direct costs such as out of pocket payments and cost of medicines purchased as well as indirect costs such as transport, food, waiting time and opportunity cost incurred while taking care of the sick child were measured in Kenya shillings but reported in USD (100 K.Shs = 1 USD) .

The interviewers were trained to probe opportunity cost borne by caregivers in the process of seeking health care for the sick child by asking them to state their occupation. From this, the approximate forgone benefit was estimated to triangulate the information gathered from their response to the direct questions posed to the caregiver about their estimated opportunity cost.

Quality assurance

Data collectors were trained for two days on the survey tool as well as the procedure in a classroom setting and then practised in the pre-test health facility outside the data collection area (Migori County). Data collection instruments were examined by supervisors and other experts to ascertain their quality and validity.

Data analysis

Data was checked for completeness, cleaned, sorted and coded. This was followed by data entry into excel (2016) spreadsheet in readiness for analysis by use of the R statistical software to compute descriptive statistics on cost of treatment. The cost of treatment was then further modeled on R (Studio) statistical package using a stepwise multiple linear regression approach.

Ethical Considerations

All principles pertaining ethical conduct of research with human subjects were adhered to in this study as embodied in the Declaration of Helsinki. Ethical approval was obtained from the Kenyatta National Hospital/University of Nairobi-Ethics and Review Committee (KNH-UON ERC Ref-**P389/05/2016**).

Patient and Public Involvement

Given that there was no funding for this study, no funds or time was allocated for patient or public involvement. We were therefore unable to involve patients. However, we plan to invite representatives of the public to help us write a plain language summary for further dissemination of the results.

RESULTS

The survey was conducted across various health facilities ranging from level II to level V. Most of the participating children, 47.6% (121), had been treated in level IV facilities. Level II facilities had 26.8% (68) of the children; level III had 21.3% (54) and level V had 4.3% (11). Most participants, 55.5% (141), were 4-6 years old. Male children were 54.7% (139) while females were 45.3% (115). Most of the participants, 62.6% (159), travelled for 2 to 5 km to reach the health facility using mainly a motorcycle as the preferred means of transport 66.1% (168). After reaching the hospital, most of them, 72% (183), waited for about one hour to be served while 18.1%(46) were attended to within 30 minutes. Medical officers, 46.5% (118) were the most common prescribers followed by clinical officers at 35.8% (91). Nurses prescribed for 17.7% (45) of the respondents. Most caregiver-respondents, 70% (178), stayed in the hospital with their children for two days or less with most of them, 61.8% (157), describing the condition of their children at admission as not very sick. Most of the participants 48 %(122) first sought

medical care in a community pharmacy outlet before proceeding to a government health facility. Table 3 is a summary of the baseline characteristics of the study participants.

Table 3: Sociodemographic characteristics of study participants

Factor	Number of children	%
Facility Level		
Level II	68	26.80
Level III	54	21.30
Level IV	121	47.30
Level V	11	4.40
Age of child		
< 1	11	4.30
1 – 3	74	29.10
4 – 6	141	55.50
7 – 9	22	8.70
10 +	6	2.40
Sex of child		
Male	139	54.70
Female	115	45.30
Distance to health facility (Km)		
< 1	40	15.70
2 – 5	159	62.60
5 – 10	50	19.70
> 10	5	2.00
Mode of Transport to health facility		
Ambulance	2	0.80
Bicycle	13	5.10
Motorcycle	168	66.10
On Foot	55	21.70
Private Vehicle	4	1.60
Public Service Vehicle	12	4.70
Waiting Time before initial treatment		
< 30 Minutes	46	18.10
1 hr	183	72.00
2 hrs	10	3.90
3 hrs	7	2.80
3 + hrs	8	3.20
Prescriber		
Clinical Officer	91	35.80
Medical Officer	118	46.50

Nurse	45	17.70
Days of Stay at the facility		
1 – 2	170	66.93
3 – 5	38	15.00
6 – 10	38	15.00
10+	8	3.10
Caregiver reported severity of Illness at admission		
Not Very Sick	157	61.80
Very Sick	97	38.20
Initial treatment site		
Community Pharmacy outlet	122	48.00
Dispensary (Level II)	39	15.40
Government Hospital	36	14.20
Private Hospital	36	14.20
Religious Leader	16	6.30
Retail Shop	5	2.00

Cost drivers for the treatment of paediatric malaria in Homa-Bay County

The individual patient-reported costs per category were analyzed and summarized as in Table 4.

Table 4: Patient reported costs of treating paediatric malaria in Homa-Bay County

	Cost of Treatment(USD)			
	Mean	**Median**	**Minimum**	**Maximum**
Transport	0.81	0.50	0	20
Food	2.29	2.00	0.20	18
Value of time used for seeking care	5.56	3.25	1	50
Direct Payment	1.38	12	0	50

Modeling the cost of treating paediatric malaria

The model representing the cost of treating paediatric malaria in Homa-Bay County was developed by use of stepwise multiple linear regression analysis of the costing data collected from the exit interviews. The full model was first formulated as shown in Table 5 followed by a reduced model **after Bootstrapping regression** shown in Table 6.

Table 5: Full Model of the cost of treatment of paediatric malaria
Full model

Full model				
Parameter	**Parameter Esti. (se)**	**95% CI**	**t-Value**	**p-Value**
		LB – UB		
Age	0,85 (0.42)	0.20-1.59	2.00	**0.047**
Facility Level				
Level II	1			
Level III	0.27 (4.08)	-9.04– 8.40	0.06	0.945
Level IV	2.20 (3.52)	-6.54– 8.84	0.63	0.533
Level V	7.39 (7.39)	-8.74 - 20.94	1.00	0.319
Distance to Facility				
1 – 2 days	1			
3 – 5	-3.87 (2.64)	-8.83– 2.26	-1.5	0.144
6 – 10	3.89 (3.53)	-8.74 – 5.93	-1.1	0.273
10 +	4.14 (6.20)	-12.31 - 12.30	0.7	0.506
Prescriber				
Clinical Officer	1			
Medical Officer	6.01(2.55)	0.92 - 11.50	2.40	**0.021**
Nurse	4.91(2.99)	-32.37 – 9.06	1.60	0.104
Days of Stay	2.11 (0.63)	0.86 – 3.35	0.94	**0.001**
Waiting Time				
<30 minutes	1			
Within 1 hr	3.03 (2.38)	-2.25 – 7.77	1.30	0.206
Within 2 hrs	3.95 (4.60)	-6.73 - 12.43	0.90	0.392
Within 3 hrs	2.75 (5.15)	-8.85 – 8.13	0.50	0.594
Initial Treatment site				
Community Pharmacy outlet	1			
Dispensary	1.59(4.05)	-8.85 – 8.13	0.40	0.696
Government Hosp	9.59 (8.15)	-5.95 - 26.12	1.20	0.242
Private Hosp	0.09 (2.91)	-4.59 – 6.86	0.03	0.976
Religious Leader	4.20 (3.02)	-0.39 - 12.23	1.40	0.168
Retail Shop	14.40 (6.84)	1.19 - 29.43	2.10	**0.038**

R2 = 68%, R2- Adjusted= 62%.

Table 6: Reduced model for cost of treating paediatric malaria in Homa Bay County

Reduced Model – After Bootstrapping Regression				
Parameter	**Parameter Est. (se)**	**95% CI**	**t-Value**	**p-Value**

Age (years)	0.83 (0.45)	-0.05-1.71	1.8	0.066
Facility Level				
Level II	1			
Level III	3.36 (3.19)	-2.97-9.69	1.1	0.294
Level IV	5.87 (2.61)	0.70-11.04	2.3	**0.026**
Level V	20.64 (5.13)	10.49-30.83	4.0	**<0.001**
Days of Stay at facility	2.38 (0.58)	1.23- 3.53	4.1	**<0.001**
Prescriber				
Clinical Officer	1			
Medical Officer	6.98 (4.29)	-1.51-15.47	2.40	0.106
Nurse	2.73 (4.63)	6.44-11.90	0.59	0.556

R^2 = 38%, **R^{2-}** Adjusted= 33%

A stepwise multiple linear regression was then performed to select the variables that contribute most meaningfully to the model. After this stepwise process, the variables that were isolated as mostly contributing to the model were age, facility levels, days of stay in the facility and prescriber. However, the statistically significant variables were days of stay in the facility (t value = 4.10, p-value < 0.001) and being treated at Level IV & V facilities (t value = 2.3, p-value < 0.05).

From the obtained model, for every additional year of age, the total cost of care increased by USD 0.82 (95% CI= -0.05 – 1.71). Compared to level II facilities, the total cost of care was more expensive by USD 14 (95% CI= 3.25, 24.78) in the level V facilities. For every additional day spent in the facility, the total cost of care increased by USD 2.35 (95% CI= 1.23, 3.48) shillings. Being prescribed medicines by a Clinical Officer led to the total cost being lower by USD. 7.5 (95% CI= 3.17, 11.76) compared to prescription by a Medical Officer. The unadjusted coefficient of determination, R^2, of the reduced model was 38% and the adjusted R^2 was 33%. This means that 33% of the relationship between cost variables and total cost as captured in this model is explained by the model and not random chance. This model thus explains 33% of the variation in costs. From the variables in the reduced model, a regression equation was developed and summarized as follows;

The Multiple Linear Regression Equation

The econometric cost model for treating paediatric malaria in Homa-Bay County generated from our data was represented by the generic equation given by;

TC = β1 **Age** - β2 **Level 3** - β3 **Level 4** + β4 **Level 5** + β5 **Days of stay** + β6 **MO** + β7 **Nurse** + **€**

Where

TC = Total Cost

Level 3 = treated at a level 3 health facility

Level 4 = treated at a level 4 health facility

Level 5 = treated at a level 5 health facility

Days of stay = Number of days the respondent stays in the facility

€ = Error term

On substitution of the values of the coefficients, the final regression equation is

Total Household Cost = 3.36***Level III** +5.87***Level IV** + 20.63***Level V** + 23.83***Days of stay** +6.98*Medical Officer +2.73*Nurse + **€**

Discussion

This study was conducted in Homa-Bay County which is in rural Western Kenya. The findings may therefore not be generalizable to other parts of the country. Costing was performed from a patient perspective. The patient perspective was considered the most appropriate because the survey focused on the individual patients at the point of exiting the process of care. The findings can therefore only be interpreted from this perspective. The median total cost (USD) was 6.5 with a mean of 10 and a range of 1.4 to 65. This was lower than those reported from a study in Zambia where the average cost was 32 for uncomplicated and USD 77 for severe complicated malaria [12] and from an earlier Kenyan Study with an average cost of USD 96 [13].

Non-user fees such as cost of transportation and food were almost double the user fees, indicating that such costs of care could be a major barrier to accessing care in this rural County even though official user fees for paediatric malaria were abolished by the government. It also shows that some facilities still charged unofficial user fees thus increasing the barrier to access. These findings concur with those from a study in Bolivia which indicated that indirect costs still impeded access to paediatric care irrespective of user fee abolition [14].

One of the main contributors to total household costs was the value of time lost in the process of seeking care. This contributor was however measured subjectively from the verbal reports of respondents. An attempt to triangulate this information was made by way of asking the

respondents to state their occupation. Most previous studies have not incorporated the cost of time lost due to care seeking in their costing models.

Compared to level II facilities, the total cost of care was more expensive by USD 14 (95% CI= 3.25, 24.78) in the level V facility. This increased total cost in higher level hospitals is in concurrence with the findings of a study in China [15]. The level V facility was centrally located in the county and had health care providers with higher academic qualifications than those in lower level facilities. Before a patient is sent to such a facility, they were likely to have gone through lower level facilities. The cases referred to it are therefore more severe or need more specialized attention than those at lower level facilities. Similarly, before a patient comes to the higher level facility, they would have spent more on transport cost since it is centrally located in the County. They would also have spent more time caring for the ill child at the lower level facility prior to referral higher level. This may explain why the cost involved is at higher level facilities is higher compared to lower level facilities.

The average number of days spent in the facility was 2 days. For every additional day spent in the facility, the total cost of care increased by USD 2.35 (95% CI= 1.23, 3.48). The number of days spent in the facility may also have been influenced by factors such the severity of illness at admission, the time taken before seeking care, quality of care and the bed capacity of the hospital [16,17].

Being prescribed medicines by a Clinical Officer led to the total cost being lower by USD 7.5 (95% CI= 3.17, 11.76) compared being prescribed to by a Medical Officer. This may be because medical doctors tend to prescribe branded medicines more than their generic versions [18]. However, in government health facilities where patients don't pay for consultation, this observation cannot be fully explained. Studies elsewhere have also reported that seeking care from medical doctors is more costly than lower cadre health care providers [19]. Medical officers were more often found in higher level facilities which are few and centrally located hence accessing them attracted more transport and hotel costs. In many cases of paediatric malaria treatment, the main cost centres are often consultation, medicines, transport and hospitalization with the most significant being the cost of medicines [20]. In the contrary, from our findings, the

greatest contributor to the total cost of care is the opportunity cost of productive time lost while caring for the sick child.

Conclusion

The Homa-Bay County Referral Hospital (level V) is much more costly than the other lower level health facilities in the county indicating that the poorest who may not afford or access the specialized treatment offered thus may be financially barred from obtaining the superior paediatric malaria care. The top two drivers of patient borne cost of paediatric malaria treatment in Homa-Bay County are being admitted at the County referral hospital and a medical officer prescribing the medication. Efforts aiming at reducing the cost of paediatric malaria treatment therefore need to focus on availing quality treatment at the lower level facilities through better trained and experienced staffing, performance monitoring and improved infrastructure.

Unanswered questions and future research

From our findings, one of the greatest contributors to cost of treatment is being treated by a medical officer. It is not clear why this would be so especially in public health facilities where patients don't pay directly for consultation. This could be some form of indictment on the training and experience as well as training on treatment guidelines of medical staff in public service. There is therefore need for further research in other Counties and regions to attempt to validate this finding.

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Data Sharing

Extra data can be accessed via the Dryad data repository at http://datadryad.org/ with the doi: 10.5061/dryad.prr4xgxhn

Competing Interests

The authors declare that they have no competing interests.

Author Contributions

The conceptualization and protocol development was done by all the authors. Data collection and analysis was done by MOK. MOK drafted the manuscript which was validated and edited by JOO and BKA. All authors gave final approval of the version to be published. All authors declare neither financial nor personal relationship conflict of interest. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Buigut S, Ettarh R, Amendah DD.Catastrophic health expenditure and its determinants in Kenya slum communities.Int J Equity Health. 2015 May 14;14:46. doi: 10.1186/s12939-015-0168-9.

2. Ayieko P, Ogero M, Makone B, Julius T, Mbevi G, Nyachiro W, Nyamai R, Were F, Githanga D, Irimu G, English M; Clinical Information Network authors. Characteristics of admissions and variations in the use of basic investigations, treatments and outcomes in Kenyan hospitals within a new Clinical Information Network. Arch Dis Child. 2015 Dec 10. [Epub ahead of print]

3. World Health Organization (2015). World Malaria Report 2015, Geneva, World Health Organization

4. Onwujekwe O, Hanson K, Uzochukwu B, Ichoku H, Ike E, Onwughalu B. Are malaria treatment expenditures catastrophic to different socio-economic and geographic groups and how do they cope with payment? A study in southeast Nigeria.Trop Med Int Health. 2010 Jan;15(1):18-25. doi: 10.1111/j.1365-3156.2009.02418.x. Epub 2009 Nov 3.

5. Sicuri E, Vieta A, Lindner L, Constenla D, Sauboin C. The economic costs of malaria in children in three sub-Saharan countries: Ghana, Tanzania and Kenya. Malar J. 2013 Sep 3; 12:307. doi: 10.1186/1475-2875-12-307.

6. Sicuri E, Davy C, Marinelli M, Oa O, Ome M, Siba P, Conteh L, Mueller I. The economic cost to households of childhood malaria in Papua New Guinea: a focus on intra-country variation. Health Policy Plan. 2012 Jul;27(4):339-47. doi: 10.1093/heapol/czr046. Epub 2011 Jun 22.

7. Barasa E, Ayieko P, Cleary S, English M. Out-of-pocket costs for paediatric admissions in district hospitals in Kenya. Trop Med Int Health. 2012 Aug;17(8):958-61. doi: 10.1111/j.1365-3156.2012.03029. x. Epub 2012 Jun 21. Page 15 of 105

8. *http://datatopics.worldbank.org/world-development-indicators/stories/the-classification-fcountries-by-income.html* Oct 4, 2018

9. UN Inter-agency Group for Child Mortality Estimation, 2019. Kenya Country Summary, March 2017

10. Kenya National Bureau of Statistics (KNBS). (2016). *Statistical Abstract 2015.* Nairobi: KNBS.

11. Johnston K, Lakzadeh P, Donato B, Szabo S. Methods of sample size calculation in descriptive retrospective burden of illness studies. BMC Med Res Methodol. 2019 Jan 9;19(1):9.doi: 10.1186/s12874-018-0657-9.

12. Comfort B, Janneke H, Sungano M, Stillman K, Gabert R, Korde S, Nachbar N, Derriennic Y, Musau S, Hamazakaza P, Zyambo K, Zyongwe N, Hamainza B and Thuma P. Hospitalization and costs incurred at the facility level after scale-up of malaria control; Pre- Post comparisons from two hospitals in Zambia. Am J Trop Med Hyg. 2014 Jan. 8; 90(1): 20-32.

13. Ayieko P, Okumu A, Griffith U and English M. The Economic burden of inpatient paediatric care in Kenya: household and provider costs for treatment of pneumonia, malaria and meningitis. Cost Eff Resource Alloc. 2009; 7:3

14. Burke RM, Rebolledo PA, Embrey SR, Wagner LD, Cowden CL, Kelly FM, Smith ER, Iñiguez V, Leon JS. The burden of pediatric diarrhea: a cross-sectional study of incurred costs and perceptions of cost among Bolivian families.BMC Public Health. 2013 Aug 2; 13:708. doi: 10.1186/1471-2458-13-708.

15. Xia S, Ma J, Wang D, Li S, Rollinson D, Zhou X. Economic cost analysis of malaria case management at the household level during the malaria elimination phase in The People's Republic of China. Infect Dis Poverty. 2016 Jun 3;5(1):50. doi: 10.1186/s40249-016-0141-x.

22.

16. **Kyaw** SS, Drake T, Ruangveerayuth R, Chierakul W, White NJ, Newton PN, Lubell Y. Cost of treating inpatient falciparum malaria on the Thai-Myanmar border. Malar J. 2014 Oct 29; 13:416. doi: 10.1186/1475-2875-13-416. Page 16 of 105

17. Beogo, Huang N, Drabo MK, Yé Y. Malaria related care-seeking-behaviour and expenditures in urban settings: A household survey in Ouagadougou, Burkina Faso. Acta Trop. 2016 Aug; 160:78-85. doi: 10.1016/j.actatropica.2016.03.033. Epub 2016 May 3.

18. Adair FR, Holmgren LR. Do drug samples influence resident prescribing behavior? A randomized trial. The American Journal of Medicine Volume 118, Issue 8, August 2005, Pages 881-88

19. Soremekun S, Kasteng F, Lingam R, Vassall A, Kertho E, Settumba S, Etou PL, Nanyonjo A, Ten Asbroek G, Kallander K, Kirkwood B; inSCALE Study Group.Variation in the quality and out-of-pocket cost of treatment for childhood malaria, diarrhoea, and pneumonia: Community and facility based care in rural Uganda. PLoS One. 2018 Nov 26;13(11):e0200543. doi: 10.1371/journal.pone.0200543. eCollection 2018.

20. Nabyonga O, Mugisha F, Okui A, Musango L, Kirigia J. Health care seeking patterns and determinants of out-of-pocket expenditure for malaria for the children under-five in Uganda. Malar J. 2013 May 31; 12:175. doi: 10.1186/1475-2875-12-175.

CHEERS checklist—Items to include when reporting economic evaluations of health interventions

Section/item	Item No	Recommendation	Reported on page No/ line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as "cost-effectiveness analysis", and describe the interventions compared.	page 1, line 2
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	page 2, line 10 to 33
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study.	page 2, line 16 to 30
		Present the study question and its relevance for health policy or practice decisions.	page 2, line 34 to 36
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	page 4, line 7 to 12;
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	page 3, line 10 to 24
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	page 1, line 12; page 4, line1;
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	Not applicable since this was simply a cost analysis
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	Not applicable since this was simply a cost analysis
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	Not applicable since this was simply a cost analysis
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	Not applicable since this was simply a cost analysis
Measurement of effectiveness	11a	*Single study-based estimates:* Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	Not applicable since this was simply a cost analysis
	11b	*Synthesis-based estimates*: Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	Not applicable since this was simply a cost analysis
Estimating resources and costs	13a	*Single study-based economic evaluation:*Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	
	13b	*Model-based economic evaluation:* Describe	page 6, line 2 to

Section/item	Item No	Recommendation	Reported on page No/ line No
		approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	page 6.
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	page 6, table 7 to 9;
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	page 6, line 23 to 25;
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	Assumption of linearity was made
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	page 6, line 23 to 25;
Results			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	page 7, line1 to 15; page 7, Table 3; page 9, Table 4; page 10, table 5; page 11, table 6; page 11, line 19 to page 12 line 2; page 12, line 3 to 16;
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Not Applicable
Characterising uncertainty	20a	*Single study-based economic evaluation:* Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	
	20b	*Model-based economic evaluation:* Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Not applicable
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	not applicable
Discussion			
Study findings, limitations,	22	Summarise key study findings and describe how they	page 12, line 13 to

Section/item	Item No	Recommendation	Reported on page No/ line No
generalisability, and current knowledge		support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	page 14, line 3
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	Information provided via the submission system
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	Information provided via the submission system

For consistency, the CHEERS statement checklist format is based on the format of the CONSORT statement checklist