

Cost of treatment of severe malaria anemia in children living in western Kenya

ABSTRACT

Background:

The cost of malaria treatment has been estimated to reduce African continents' GDP by \$12 billion, which is larger than the entire GDP of many Sub-Saharan countries. The western region in Kenya is holoendemic to malaria and experience stable *P. falciparum* malaria transmission. Households and health care providers in these regions incur costs in the management of malaria and malaria complications. The costs incurred by the household and health care providers in the management of severe malaria anemia in children 10 years and below remains unknown.

Methods: The current study targeting children ≥ 10 years ($n=271$) admitted and diagnosed with SMA (hemoglobin <5.0 g/dl and any density *P. falciparum* parasitaemia) was conducted at Jaramogi Odinga Oginga Teaching and Referral Hospital (JOOTRH) following their parental consent and meeting the inclusion criteria. Structured Case Report Forms were used to extract data from the participant's medical files. Parents/guardians of the participants were interviewed on the costs incurred throughout the management of the disease. Mean costs per cost item was calculated. Costs were then disaggregated by age and gender. Student's t-test was used to test for the differences in the cost of treatment by age and gender. Chi-square analysis was used to test for the differences between age groups as well as gender in relation to those who paid or did not pay the cost of treatment.

Results: It would cost an overall average of US\$ 38.83 per child to treat a case of SMA in western Kenya. The mean cost of treating a child <5 years and >5 years was nearly the same at US\$ 38.95 and US\$ 38.44 respectively ($p=0.7850$). The mean household cost was US\$ 21.10 of which when further disaggregated to <5 and >5 years old, the <5 year olds had significantly lower mean household cost of US\$ 18.43 compared to US\$ 30.08 in the >5 year olds ($p<0.001$). The mean provider cost was US\$ 21.83 of which when further disaggregated to <5 and >5 year olds, the mean provider cost for the <5 year olds (US\$ 22.55) was significantly higher compared to mean provider cost for the >5 year olds (US\$ 17.22, $p=0.0027$).

Keywords: severe malarial anemia, malaria admissions, malaria costs, malaria age patterns

15 1. INTRODUCTION

16

17 Malaria remains one of the most prevalent parasitic infection in sub-Saharan Africa [1]. In
 18 humans, it is caused by four Plasmodium species namely, *P. falciparum*, *P. vivax*, *P. ovale*
 19 and *P. malariae* . Of these, *P. falciparum* is the major cause of severe morbidity and
 20 mortality.[2] There is no doubt of the importance of *P. falciparum* malaria as a major cause
 21 of human suffering and economic drain across sub-Saharan Africa[3]. In 2016 alone, there
 22 were an estimated 216 million cases of malaria in 91 countries, an increase of 5 million cases
 23 over 2015. 445 000 malaria deaths were confirmed (reported), a similar number (446 000) in
 24 2015.The WHO African Region carries a disproportionately high share of the global malaria
 25 burden. In 2016, the region was home to 90% of malaria cases and 91% of malaria deaths. [4]
 26 *P. falciparum*-related morbidity and mortality primarily occurs in immune-naïve infants and
 27 young children.[5] Severe malaria presents with overlapping clinical sequelae that include
 28 severe malarial anemia (SMA), metabolic acidosis, respiratory distress, cerebral malaria
 29 (CM) and hypoglycemia.[6] In *P. falciparum* holoendemic transmission areas such as
 30 western Kenya, severe malaria is a predominant cause of under-five morbidity and
 31 mortality,[7] presenting primarily as SMA (Hb<5.0 g/dL and any density parasitemia)[8].
 32 However, the high morbidity and mortality caused by malaria has led to the scaling up of
 33 effective malaria interventions especially in endemic regions. These have led to substantial
 34 decline in malaria transmission, morbidity and mortality.[9] In malaria endemic areas, such
 35 as western Kenya, the development of acquired immunity is being hampered by the
 36 development and implementation of malaria control strategies leading to a possibility of a
 37 shift in age of severe malaria infection from younger to older children[10]
 38 Malaria is a disease of poverty stricken and underdeveloped countries and in general, where
 39 malaria prospers most, human societies prospered least.[11] Malaria has been shown to
 40 impede development by its effect on fertility, population growth, worker productivity,
 41 absenteeism, premature mortality and medical cost. [12]
 42 A study carried out on the economic costs of malaria in children in three sub-Saharan
 43 countries: Ghana, Tanzania and Kenya [13] revealed that household and health system costs
 44 per malaria episode ranged from approximately US\$ 5 for non-complicated malaria in
 45 Tanzania to US\$ 288 for cerebral malaria with neurological sequelae in Kenya. On average,
 46 up to 55% of these costs in Ghana and Tanzania and 70% in Kenya were assumed by the
 47 household, and of these costs 46% in Ghana and 85% in Tanzania and Kenya were indirect
 48 costs. The treatment costs per episode per child ranged from a minimum of US\$ 1.29 for

children aged 2–11 months in Tanzania to a maximum of US\$ 22.9 for children aged 0–24 months in Kenya. Average treatment costs per case in Ghana, Tanzania and Kenya was of US\$ 11.99, US\$ 6.79 and US\$ 20.54, respectively[14]

In Malawi, a cross-sectional survey conducted in 2012 to determine the household cost among patients hospitalized with malaria showed that the total household cost averaged US\$17.48 per patient, and indirect household costs averaged \$7.59 and \$9.90, respectively[15]

Studies have been done on cost of malaria treatment in general but little is known of the cost of treating specifically SMA, which is one of the common presentations of severe malaria. Also, most studies have concentrated on children below 5 years of age. However, with the possibility of a shift in ages of presentation of severe malaria from the younger children to older children due to the envisaged introduction of malaria vaccine in the 5-17 months age group in 2018[4], there is the threat of lack of development of natural immunity. It is thus equally important to know what it would cost to treat the older children. This study therefore sought to find out the costs (household and provider) of management of severe malarial anemia in children 10 years and below at Jaramogi Odinga Odinga Teaching and Referral Hospital (JOOTRH) in western Kenya, a holoendemic region for malaria that experiences stable *P. falciparum* transmission throughout the year with peak seasons following the long rains (March to May) and the short rains (October to December).

2. MATERIAL AND METHODS

2.1. Study site.

The study was conducted in Jaramogi Odinga Odinga Teaching and Referral Hospital (JOOTRH) located in Nyanza region of western Kenya, around L. Victoria, an area that is holoendemic for malaria and experience stable *P. falciparum* transmission (altitude 0-1300 meters). Data from Health Management Information System in JOOTRH (the largest referral health facility in Nyanza region) shows that malaria accounts for 40% of out-patient visits and 40% of hospital in-patient admissions with between 10-15 paediatric cases of severe malaria often complicated with anaemia and malnutrition, on a daily basis [16]. Malaria transmission occurs all year round, peaking in the rainy season months of April and May and continuing to August. The rainwaters also expose a major reservoir for breeding of mosquitoes creating persistent malaria endemic environment. The region experiences warm climate of 20-30°C throughout the year. The humid, warm and mostly swampy environment

83 makes the area a prime breeding ground for the female anopheles mosquito, the vector for the
84 malaria parasite [17].

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86 **2.2. Study design**

87 **2.2.1. Study site and population**

88 This was a hospital based cross-sectional study that targeted children 10 years and below
89 admitted and diagnosed with severe malarial anaemia (hemoglobin concentration <5.0 g/dl
90 and any density *P. falciparum* parasitaemia- based on WHO definition) [18]. Participants
91 were recruited from Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH),
92 the largest referral hospital in western Kenya that serves both the urban and rural.

93 **2.2.2. Inclusion criteria**

94 All children the age of 10 years (inclusive) who were diagnosed to have SMA were
95 approached to participate in the study. All the caretakers of the children enrolled in the study
96 were also interviewed. The caretakers consented for their children to participate in the study
97 and also for themselves to be interviewed. All children had to be resident of western Kenya.
98 The children had to be admitted at JOOTRH as it was the health provider.

99 **2.2.3. Exclusion criteria**

100 Children with known blood disorders like sickle cell trait were excluded from the study.
101 Those whose caregivers did not provide informed consent and children non-resident of
102 western Kenya were excluded.

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104 **2.2.4. Sample size determination**

105 A total of 271 children were enrolled in the study.

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107 **2.2.5 Sampling design**

108 As patients presented to the health facility and diagnosis of severe malaria anemia was made,
109 the patients who met the inclusion were approached for consent to participate in the study.
110 This was done until the desired sample size was achieved.

2.3. Data Collection instruments/tools.

Structured Case Report Forms were used to extract data from the medical files of patients admitted with severe malarial anemia. The following information was extracted from the patient's files: demographic information, dates of admission, investigations, diagnosis, treatment given and outcomes. Some information on expenses used on the patient were also extracted from the hospitals records/receipts. Caretakers of the patients were interviewed on the costs. Data for the health provider was extracted using the case report forms from the hospital master price lists. Some of the data extracted included bed charges, drug costs, lab costs.

2.4. Data Analysis

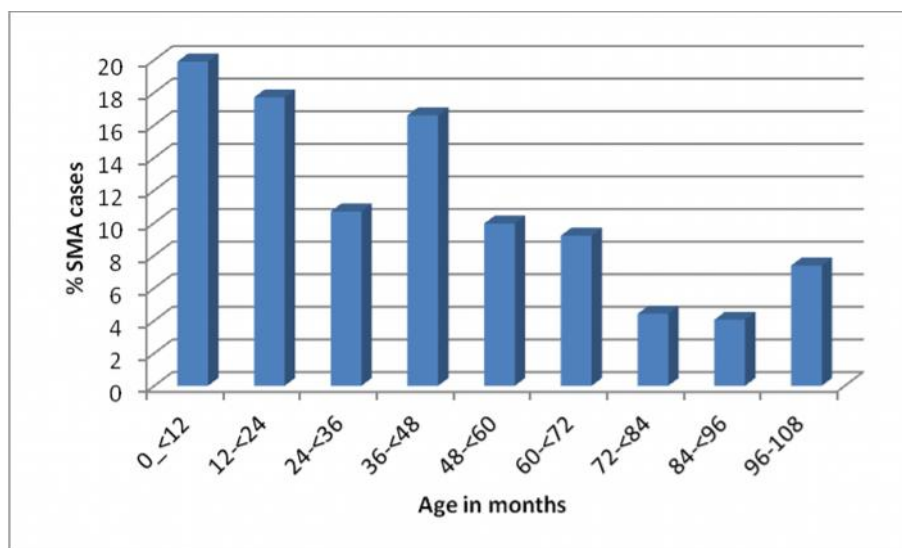
To determine the household and provider economic burden of malaria, the costs were classified as all cash spending due SMA illness at household and provider level. Household costs included spending on consultation, drugs, lab tests, bed charges, gifts, transport, special foods and any other cost that a household incurred due to illness. Provider costs included drugs, laboratory, ward charges and other charges incurred to manage the illness. The average cost per child was calculated by summing up the mean cost per cost item for both household and provider expenditures. The costs were then disaggregated by age categories for under <5 and >5 and gender. Chi-square test was used to compare the proportions of the age categories and gender. t-test was used for mean costs comparisons

3. RESULTS

3.1. Demographic characteristics

A total of 271 children presenting with severe malaria anemia were evaluated for the cost of treatment. As shown in Figure 1, majority of the patients were less than 60 months (74.9%, 203/271). 62% (167) of the patients were males compared to 38% (104) females (Figure 2). Of all the respondents interviewed, 80.1% (217) had attained Primary education only. 14.8% (40), 4.8% (13), and 0.4% (1) had attained Secondary, Tertiary, and University level of education, respectively (Figure 3).

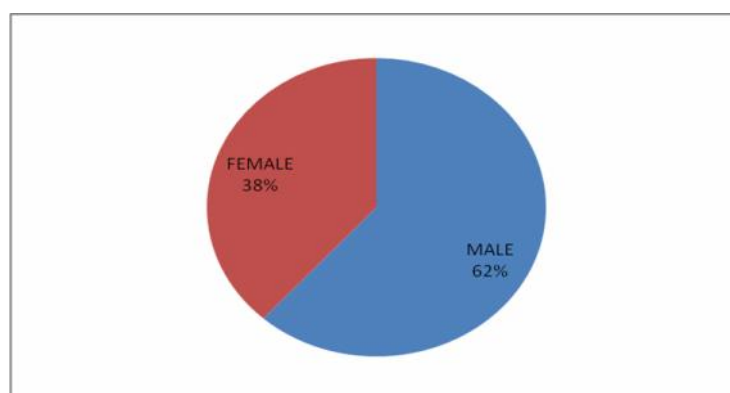
145 Figure 1. Age in months and % cases of SMA



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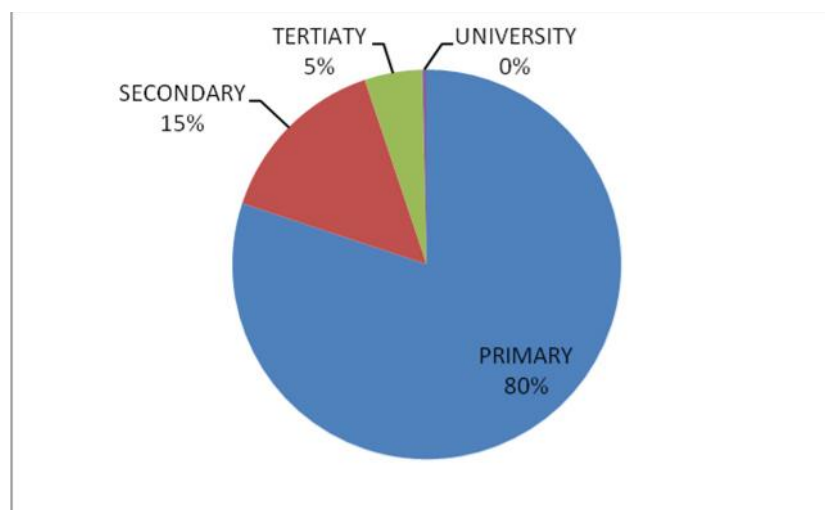
148 Figure 2. Gender of child



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150 Figure 3. Level of education of parent/guardian

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3.2. Household Costs

An assessment of the household cost of treating SMA showed that almost all the patients (99.6%, 270/271) incurred some household cost. As shown in Table 1, the average household cost per child was US\$ 21.10 (range US\$1.20 to US\$70.52). Majority of the SMA patients who incurred the household cost were below the age of 5 years (202, 74.8%). The household cost was US\$ 18.40 per every <5 year old, which was significantly lower compared to the US\$ 29.14 paid by the ≥5 year olds ($p<0.001$). Only 23.2% ($n=63$) of the participants incurred the cost of laboratory tests. The mean was US\$ 5.97 and it ranged from US\$1.90 to US\$ 28.40. Of these 63 patients, 36.5% (23) were below 5 years. When the household cost of laboratory tests was determined of the basis of age, there was no significant difference in the cost incurred between the <5 year olds and ≥5 year olds (mean US\$ 6.30 vs. US\$5.79, $p=0.77$).

A total of 194 (71.5%) of the participants incurred the cost of SMA drugs. This amounted to US\$ 7.32 per child. Interestingly, the cost incurred by patients ≥5 years ($n=51$) was significantly higher (US\$11.33) compared to the cost incurred by those below 5 years ($n=143$) (US\$5.73, $p<0.001$). With regard to ward expenses, 78.5% ($n=213$) of the participants incurred a mean cost of US\$ 5.88 (range, US\$ 2.20 to US\$ 24.70) as ward fees. The cost was significantly higher in children above 5 years (US\$ 12.96) compared to children below 5 years (US\$ 11.18, $p=0.05$). The cost of transport to and from the hospital was met by almost all the participants (270/271). The cost was about US\$ 2.35 per child, and did not vary significantly with regard to age (Table 1). Other expenses such as X, Y, and Z were also incurred by the participants during SMA treatment. Of the 271 study patients, only 117 (43.7%) incurred these ‘other costs’ which amounted averagely to US\$ 6.62 per child. These ‘other costs’ were significantly higher in children above 5 years compared to children below 5 years (8.41 vs. 3.52, $p<0.001$)(Table 1).

Table 1. Household costs by age categories

	Age category (n,%)				Household cost (US\$) of treating SMA, Mean cost (Range)			
	n(%)	<5yrs (n,%)	≥5yrs (n,%)	p-Value	Overall Mean cost	<5yrs	≥5yrs	p-Value
Lab costs	63(23.2)	23(36.5)	40(63.5)	<0.001	5.97 (1.90-28.40)	6.30 (1.90-23.40)	5.79 (1.90-28.40)	0.77
Drug costs	194(71.5)	139(71.6)	55(28.4)	0.23	7.32 (0.30-26.40)	5.73(0.30-21.70)	11.33 (0.60-26.40)	<0.001
Ward costs	213(78.5)	151(70.9)	62(29.1)	0.07	11.70 (2.20-24.70)	11.18 (2.20-19.70)	12.96 (4.70-24.70)	0.05
Transport costs	270(99.6)	202(74.8)	68(25.2)	1	2.35 (0.20-20.80)	2.29 (0.20-20.80)	2.53 (0.30-14.00)	0.81

Other costs	117(43.7)	74(63.2)	43(36.8)	< 0.001	6.62(0.74-14.70)	8.41 (1.24-14.70)	3.52 (0.74-14.73)	<0.001
TOTAL	270(99.6)	202(74.8)	68(25.2)	0.07	21.10 (1.20-70.52)	18.40 (1.50-65.58)	29.14(1.20-70.52)	<0.001

3.3. Provider costs

With regard to health provider, 221 (81%) had part of the cost of treating SMA paid for by the health care provider. This averaged to US\$ 21.83 per child. It costed the health provider US\$ 22.55 to treat SMA patients below 5 years, which was significantly higher compared to the cost they paid for SMA patients above 5 years (US\$ 17.22, $p=0.03$) (Table 2). Part of the payment catered for the cost of laboratory tests, drugs, ward fee as well as other contingencies such as X, Y and Z. On the cost of laboratory tests, the health provider paid for 209 (77.1%) SMA patients, which amounted to US\$ 6.27 per child. Although not statistically significant, much of this payment went to patients below the age of five years (US\$ 6.54 per child versus US\$ 4.07 in children above 5 years) (Table 2). The cost of drugs, ward fee and other contingencies paid for by the healthcare provider did not vary significantly between the SMA patients below 5 years and those above 5 years ($p>0.05$) (Table 2).

Table 2. Health provider costs by age category

	Age category (n,%)				Health provider cost (US\$) of treating SMA, Mean cost (Range)			
	n(%)	<5yrs (n,%)	≥5yrs (n,%)	p-Value	Overall Mean cost	<5yrs	≥5yrs	p-Value
Lab costs	209 (77.1)	186 (88.9)	23 (11.0)	<0.001	6.27 (1.00-28.40)	6.54 (1.00-28.40)	4.07 (1.90-6.90)	0.06
Drug costs	216 (79.7)	188 (87)	28(12.9)	< 0.001	9.32 (.30-22.60)	9.28 (.30-19.20)	9.57 ((.30-22.60)	0.73
Ward costs	207 ((76.3)	185 (89.3)	22(10.6)	< 0.001	5.37 (.50-14.38)	5.39 (.50-14.38)	5.22 (5.00-10.00)	0.64
Other costs	200 (73.8)	177 (88.5)	23(11.5)	< 0.001	1.95 (.16-5.34)	1.95 (.24-5.34)	1.80 (.16-3.50)	0.33
TOTAL	221 (77.8)	191 (86.4)	30 (13.5)	< 0.001	21.83 (.16-54.76)	22.55 (5.00-54.76)	17.22 (.16-33.70)	0.03

3.4 Gender and costs

166(61.4%) males incurred household cost with a mean cost of US\$ 21.10 per child while 104 (38.5%) females incurred household costs with a mean of US\$ 21.27 per child. (Table 3) The health provider incurred cost on 139(62.8%) males. Mean cost incurred on them was US\$ 21.44. They also incurred cost of 82(37.1%) females. The mean cost incurred on them was US\$ 22.49. (Table 4)

Table 3: Household costs and gender

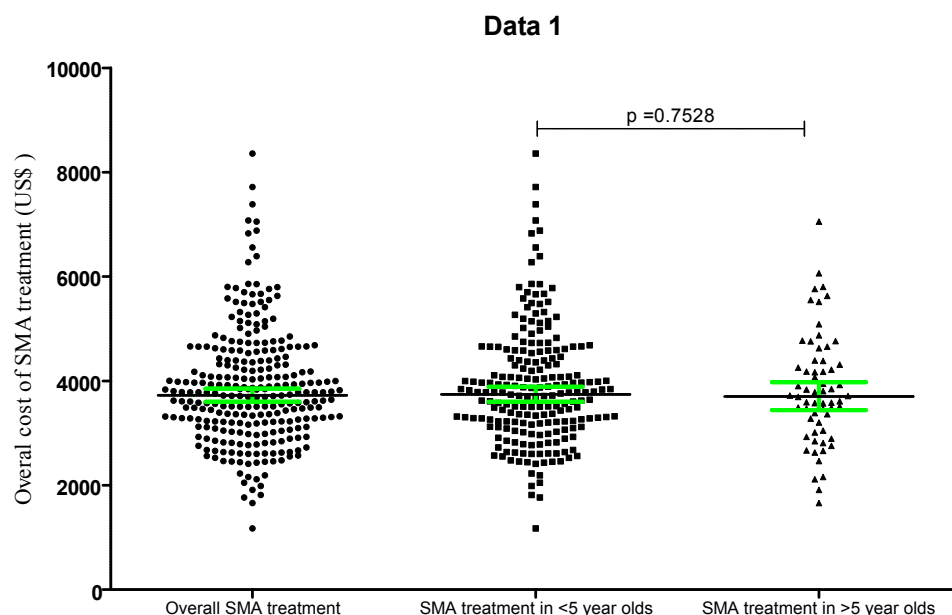
	Gender (n,%)			Household cost (US\$) of treating SMA, Mean cost (Range)		
	Male (n,%)	Female (n,%)	p-Value	Male	Female	p-Value
Lab costs	37 (58.7)	26 (41.3)	0.66	6.00 (1.90-23.40)	5.94 (1.90-28.40)	0.86
Drug costs	119 (61.3)	75 (38.9)	1	7.46 (.30-26.40)	7.09 (.35-18.10)	0.88
Ward costs	134(62.9)	79(37.1)	0.45	11.51 (2.20-24.70)	12.01 (4.70-19.70)	0.36
Transport costs	166(61.4)	104(38.6)	1	2.32 (.20-20.18)	2.39 (.20-14.00)	0.76
Other costs	69(58.9)	48(41.1)	0.45	6.48 (.74-14.70)	6.80 (1.16-14.70)	0.70
TOTAL	166(61.4)	104(38.6)	1	21.00 (1.20-65.58)	21.27 (4.90-70.52)	0.40

Table 4: Heath provider costs and gender

	Gender (n,%)			Household cost (US\$) of treating SMA, Mean cost (Range)		
	Male (n,%)	Female (n,%)	p-Value	Male	Female	p-Value
Lab costs	130 (62.2)	79 (37.8)	0.77	6.28 (1.90-28.40)	6.24 (1.00-26.40)	0.80
Drug costs	135 (62.5)	81(37.5)	0.64	9.04 (.30-22.60)	9.78 (.30-20.00)	0.52
Ward costs	130(62.8)	77(37.2)	0.56	5.40 (.50-12.50)	5.33 (1.90-14.38)	0.26
Other costs	126(63)	74(37)	0.48	1.90 (.16-4.54)	1.99 (.66-5.34)	0.70
TOTAL	139(62.8)	82(37.2)	0.42	21.44 (.16-54.76)	22.49 (3.90-47.54)	0.30

3.5 Overall cost of treatment of SMA (household and provider combined)

Costs were incurred on all the 271 (100%) children in the study. It costs a mean of US\$ 38.83 to treat SMA per child at JOOTRH. It costs a mean of US\$ 38.95 to treat a child below 5 years (77.1%) and US\$ 38.44 to treat a child above 5 years, 62(22.8%).(Figure 4).



4. DISCUSSION

The aim of this study was to find out the costs incurred by the households and government health provider in the management of a child admitted with SMA. The total cost, household and provider of treatment of SMA was a mean of Ksh 3883. This is slightly higher from a study in Tanzania on the economic costs of malaria in children in three sub-Saharan countries: Ghana, Tanzania and Kenya[13] which revealed that Household and health system costs per malaria episode was approximately US\$ 288 for complicated malaria. It is possible that the difference in costs could be as a result of the time difference which has come with adjusted costs for both the household and the health care provider

Another study [19] showed that the unit recurrent costs per admission in Kilifi District Hospital ranged from US \$57 for 'other' paediatric malaria to US \$105 for cerebral malaria while at Malindi Sub-district Hospital the costs ranged from US \$33 'other' paediatric to US \$44 cerebral. This is high compared with the current study. It shows that the costs differ substantially with the type of severe malaria.

The study revealed, that there was no much difference in the total cost of treatment of malaria in a child <5 and >5. The mean cost of treatment of a child <5 was Ksh3895 and the mean cost of treatment of a child > 5 was Ksh3844, However the difference was found in who bears the highest costs. It was found out that in children <5, the provider incurred higher costs, mean cost of Ksh 2255 per child while the household incurred a lesser cost of

Ksh.1843. For the children >5 years, the household incurred higher cost, mean cost of Ksh3008 while the provider incurred a lesser cost of a mean of Ksh 1722. These differences is as a result of the health provider providing some health services to the <5 free of charge thus the lesser costs for the households. For the above > 5 years the household meets most of the costs by themselves thus higher costs to the household but less to the care provider. The Kenya government has a policy that the treatment of malaria for the under 5 is free. It would then be expected that children < 5year would not incur any costs on drugs and lab tests. The study showed that children <5 paid a mean cost of Ksh578 per child on drugs and a mean cost of Ksh 620 on lab tests per child. This could be that children under five may have been having other co-morbidities like respiratory distress together with the SMA that required treatment and other lab tests. There were times that the hospital lacked some drugs needed for treatment of SMA making the parents/guardians of children <5 years to buy. Children >5 years according to government policy pay for treatment of malaria. It would then be expected that the household meet the full cost of this treatment. However this was found not to be the case. As much as the household incurred a higher cost compared to the children below 5 years, that health provider took in some cost of drugs mean cost Ksh 407, lab mean cost Ksh 957. On a case by case basis the health provider would come in on the very needy cases for children > 5 years and waive the costs incurred by the households. There was no statistically significant difference on the costs of managements of SMA between male and Female participants. This can be explained by the fact that management of SMA is the same for any gender equally resources are allocated without discrimination of gender.

5. CONCLUSION

It was concluded that SMA was more common in children under 5 compared to children above 5 and affects more males than females. The mean total cost of treatment of SMA was the same for children under 5 and above 5. The difference was who bore the highest costs. The provider bore the highest cost for children under 5 and the households bore the highest cost for children above 5. Even though treatment of malaria for the under 5 is considered free, the households still incur costs in the management of SMA. JOOTRH is a regional referral hospital. It would be of interest to compare the costs at the National and County government health facilities as they also do admit patients with SMA.

RECOMMENDATION

Malarial burden is high in Western Kenya. The management of Malaria and the complications of malaria such as SMA should be made free for all children under 10 years.

The government together with the hospital should ensure that all the drugs and lab tests needed for management of malaria and its complications are always available..

The government needs to ensure that the health care providers in western Kenya receive enough financial allocation so that all children under 10 years with malaria and or malaria with complications are treated free.

There is need to carry out a similar study to look for co- morbidities in SMA and how much they contribute to the costs

There is need to repeat this study after malaria vaccine introduction which is planned to begin 2018 to see if there is age shift in presentations.

DISCLAIMER

The findings and conclusions presented in this manuscript are those of the authors and do not necessarily reflect the official position of Maseno University or JOOTRH. The corresponding author had full access to the study data and had final responsibility for the decision to submit for publication.

ETHICAL APPROVAL

Approval was obtained from Maseno Ethical Review committee and Jaromogi Oginga Odinga Teaching and Referral Hospital (JOORTH) before the study begun.

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