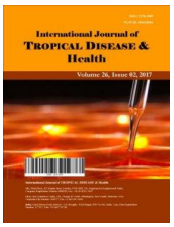

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# Cost of Treatment of Severe Malarial Anemia in Children Living in Western Kenya

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author SMOG designed the study, wrote the protocol, performed the statistical analysis, and wrote the first draft of the manuscript. Authors CO, HA and WO and performed the statistical analysis and managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** The Western region in Kenya is holoendemic to malaria and experiences stable *P. falciparum* malaria transmission. Households and healthcare providers in this region incur costs in the management of malaria and malaria related complications. However, information regarding the cost of severe malaria anemia (SMA) management remains almost unknown. The aim of this study was to study the costs incurred by the household and healthcare providers in the management of SMA in children of 10 years and below.
**Study Design:** Cross-section study.
**Place and Duration of Study:** Jaramogi Odinga Oginga Teaching and Referral Hospital (JOOTRH) from September 2014 to July 2015.
**Methodology:** It was open to all children ≤10 years (n=271) admitted and diagnosed with SMA (hemoglobin <5.0 g/dl and any density *P. falciparum* parasitemia). Data were extracted from the participants' medical files. Parents/guardians of the participants were interviewed on the costs incurred throughout the management of the disease.

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**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 for <5 years old was significantly lower at US$ 18.43 compared to US$ 30.08 in the >5 years old children (p<0.001). The mean provider cost was significantly higher in the <5 years old as (US$ 22.55) compared to US$ 17.22 in the >5 years old (p=0.0027) children.
**Conclusion:** Mean total cost for SMA treatment was same for children under 5 years and above 5 years of age. The difference was who spent the highest costs. The provider incurred the highest cost for children under 5 and the households incurred the highest cost for children above 5 years. Even though treatment of malaria for the under 5 years old children is considered free of cost, the households still incur costs in the management of SMA.

*Keywords: Children; severe malaria anemia; treatment; cost; Kenya.*

## 1. INTRODUCTION

Malaria remains one of the most prevalent parasitic infections in sub-Saharan Africa [1]. In humans, it is caused by five Plasmodium species namely, *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae* and *P. knowlesi*. Of these, *P. falciparum* is the major cause of severe morbidity and mortality [2]. There is no doubt that *P. falciparum* malaria is a major cause of human suffering and economic drain across sub-Saharan Africa [3]. In 2016 alone, there were an estimated 216 million cases of malaria in 91 countries, an increase of 5 million cases over 2015. Reports confirmed 445 000 malaria deaths and a similar number (446 000) was reported in 2015. The WHO African Region carries a disproportionately high share of the global malaria burden. In 2016, the region was home of 90% of malaria cases and 91% of malaria deaths [4].

*P. falciparum*-related morbidity and mortality primarily occurs in immune-naïve infants and young children [5]. Severe malaria presents with overlapping clinical sequelae that includes severe malarial anemia (SMA), metabolic acidosis, respiratory distress, cerebral malaria (CM) and hypoglycemia [6]. In *P. falciparum* holoendemic transmission areas such as Western Kenya, severe malaria is a predominant cause of morbidity and mortality for under-five years old children [7], presenting primarily as SMA (Hb<5.0 g/dL and any density parasitemia) [8]. However, the high morbidity and mortality caused by malaria have led to the scaling up of effective malaria interventions, especially in endemic regions. These have led to a substantial decline in malaria transmission, morbidity, and mortality.[9] In malaria endemic areas, such as Western Kenya, the development of acquired immunity is being hampered by the development and implementation of malaria control strategies leading to a possibility of a shift in age of severe malaria infection from younger to older children [10].

Malaria is a disease of poverty-stricken and underdeveloped countries, and in general, where malaria prospers most, human societies prosper least [11]. Malaria has been shown to impede development by its effect on fertility, population growth, worker productivity, absenteeism, premature mortality and medical cost [12].

A study carried out on the economic costs of malaria treatment in children in three sub-Saharan countries: Ghana, Tanzania, and Kenya revealed that household and health system costs per malaria episode ranged from approximately US$ 5 for non-complicated malaria in Tanzania to US$ 288 for cerebral malaria with neurological sequelae in Kenya. On an average, up to 55% of these costs in Ghana and Tanzania and 70% in Kenya were assumed by the household, and of these costs, 46% in Ghana and 85% in Tanzania and Kenya were indirect 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 [13].

In Malawi, a cross-sectional survey was conducted in 2012 to determine the household cost among patients hospitalized with malaria. The study showed that the total household cost averaged US$17.48 per patient, and indirect household

costs averaged $7.59 and $9.90, respectively [14].

Studies have been done on the 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. Thus, it is 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 of ten years and below at Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH) in Western Kenya. This area is 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. MATERIALS AND METHODS

### 2.1 Study Site

The study was conducted from September 2014 to July 2015 at Jaramogi Odinga Oginga Teaching and Referral Hospital (JOOTRH) located in Nyanza region of Western Kenya, around L. Victoria, an area that is holoendemic for malaria and experiences stable *P. falciparum* transmission (altitude 0-1300 meters). Data from Health Management Information System in JOOTRH (the largest referral health facility in Nyanza region) showed that malaria accounts for 40% of outpatient visits and 40% of hospital inpatient admissions with 10-15 pediatric cases of severe malaria often complicated with anemia and malnutrition, on a daily basis [15]. Malaria transmission occurs all year round, peaking in the rainy season months of April and May and continuing to August. The rain water also exposes a major reservoir for breeding of mosquitoes creating a persistent malaria endemic environment. The region experiences the warm climate of 20-30°C throughout the year. The humid, warm and mostly swampy environment makes the area a prime breeding ground for the female Anopheles mosquito, the vector for the malaria parasite [16].

### 2.2 Study Design

#### 2.2.1 Study site and population

This was a hospital-based cross-sectional study that targeted children of ten years and below, admitted and diagnosed with SMA (hemoglobin concentration <5.0 g/dl and any density *P. falciparum* parasitaemia- based on WHO definition) [17]. Participants were selected from Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH), the largest referral hospital in Western Kenya that serves both the urban and rural.

#### 2.2.2 Inclusion criteria

All children of the age of 10 years (inclusive) who were diagnosed to have SMA were approached to participate in the study. All the caretakers of the children enrolled in the study were also interviewed. The caretakers consented for their children to participate in the study and also for themselves to be interviewed. Residents of Western Kenya only were selected for the study. Another inclusion criterion was children had to be admitted at JOOTRH as it was the healthcare provider.

#### 2.2.3 Exclusion criteria

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

#### 2.2.4 Sample size determination

A total of 271 children were enrolled in the study. Sample size was determined using the following formula:

$$n=\frac{Z^2p(1-p)}{d^2}$$ (Daniel, 1999, Naing, 2006)

The prevalence of admission with inpatient malaria in the health facility was 20%. Z statistic was at 95% which is conventional with a Z value of 1.96 and the precision set at 0.05 to obtain a confidence interval width of 10%.

$$\frac{(1.96)^2\,(0.2)\,(0.8)}{(0.05)^2} = 245.8$$

This gave an estimate of 246 participants, plus 10% for non-responding, giving a total of 271. All

the caretakers of the 271 children enrolled in the study, were also interviewed.

#### 2.2.5 Sampling design

The SMA diagnosed patients with health facility, who met the inclusion criteria were approached for consent to participate in the study. 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 the patients admitted with SMA. 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 was also extracted from the hospital's records/receipts. Caretakers of the patients were interviewed on the costs of treatment. Data of 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 and laboratory costs.

### 2.4 Data Analysis

To determine the household's and providers' economic burden of malaria management, the costs were classified as all cash spending due to SMA illness at household and provider level. Household costs included spending on consultation, drugs, laboratory tests, bed charges, gifts, transport, special foods and any other costs that a household incur due to illness. Provider costs included drugs, laboratory, ward charges and other charges to manage the disease. The average cost per child was calculated by summing up the mean cost per item for both household and provider expenditures. The costs were then disaggregated by age categories for <5 and >5 years and gender. Chi-square test was used to compare the proportions of the age categories and gender. t–test was used for mean cost comparisons. P-value less than 0.05 was considered statistically significant.

## 3. RESULTS

### 3.1 Demographic Characteristics

A total of 271 children presenting with severe malaria anemia were evaluated for the cost of treatment. Majority of the patients were less than 60 months (74.90%, 203/271). The patients were mainly males at 61.62% (167) while females were 38.37% (104). Majority of the respondents were interviewed. It was fount that80.07% (217) had attained Primary education, whereas, 14.76% (40), 4.79% (13), and 0.36% (1) had attained Secondary, Tertiary, and University level of education, respectively (Table 1).

### 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 (ranged from 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 years old child, which was significantly lower compared to the US$ 29.14 paid for the ≥5 years old child ($p<0.001$). 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 on the basis of age, there was no significant difference in the cost incurred between the <5 years and ≥5 years old (mean US$ 6.30 vs. US$5.79, $p=0.77$) children.

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 purchase of blood giving set, branulas needles and syringes were also incurred by the participants during SMA treatment. Out of 271 patients, only 117 (43.7%) incurred those 'other costs' which amounted averagely to US$ 6.62 per child. Those '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 2).

**Table 1. Demographic characteristics**

| Age of child | Frequency (%) N=271 | Gender of child | Frequency (%) N=271 | Level of education | Frequency (%) N=271 |
|---|---|---|---|---|---|
| Below 5 years | 203(74.90) | Male | 167(61.62) | Primary | 217(80.07) |
| Above 5 years | 68(25.09) | Female | 104(38.37) | Secondary | 40(14.76) |
| | | | | Tertiary | 13(4.79) |
| (months) | | | | University | 1(0.36) |
| 0-<12 | 54(19.92) | | | | |
| 12-<24 | 48(17.71) | | | | |
| 24-<36 | 29(10.74) | | | | |
| 36-<48 | 45(16.60) | | | | |
| 48-<60 | 27(9.96) | | | | |
| 60-<72 | 25(9.22) | | | | |
| 72-<84 | 12(4.42) | | | | |
| 84-<96 | 11(4.05) | | | | |
| 96-<108 | 15(5.53) | | | | |
| >108 | 5(1.84) | | | | |

**Table 2. Household costs by age categories**

| | Age category (n,%) | | | Household cost (US$) of treating SMA, Mean cost (Range) | | |
|---|---|---|---|---|---|---|
| **Items** | **<5yrs (n,%)** | **≥5yrs (n,%)** | **p-Value** | **<5yrs** | **≥5yrs** | **p-Value** |
| Laboratory costs | 23(36.5) | 40(63.5) | <0.001 | 6.30 (1.90-23.40) | 5.79 (1.90-28.40) | 0.77 |
| Drug costs | 139(71.6) | 55(28.4) | 0.23 | 5.73(0.30-21.70) | 11.33 (0.60-26.40) | <0.001 |
| Ward costs | 151(70.9) | 62(29.1) | 0.07 | 11.18 ( 2.20-19.70) | 12.96 (4.70-24.70) | 0.05 |
| Transport costs | 202(74.8) | 68(25.2) | 1 | 2.29 (0.20-20.80) | 2.53 (0.30-14.00) | 0.81 |
| Other costs | 74(63.2) | 43(36.8) | < 0.001 | 8.41 (1.24-14.70) | 3.52 (0.74-14.73) | <0.001 |
| TOTAL | 202(74.8) | 68(25.2) | 0.07 | 18.40 (1.50-65.58) | 29.14(1.20-70.52) | <0.001 |

*Chi-square analysis was used to compare the differences between the number of <5 years old and those ≥5 years who incurred the cost of treating SMA. Overall, most patients <5 years incurred the cost of treating SMA when compared to those ≥5 years, although the difference was not statistically significant (p = 0.07). Student t-test was used to compare the cost of treating SMA between the <5 year olds and ≥5 year olds. Overall, the <5 years old incurred a significantly higher treatment cost than the ≥5 years old (p < 0.001).*

**Table 3. Health provider costs by age category**

| | Age category | | | Health provider cost (US$) of treating SMA, Mean cost (Range) | | |
|---|---|---|---|---|---|---|
| **Items** | **<5yrs (n,%)** | **≥5yrs (n,%)** | **p-Value** | **<5yrs** | **≥5yrs** | **p-Value** |
| Laboratory costs | 186 (88.9) | 23 (11.0) | <0.001 | 6.54 (1.00-28.40) | 4.07 (1.90-6.90) | 0.06 |
| Drug costs | 188 (87) | 28(12.9) | < 0.001 | 9.28 (.30-19.20) | 9.57 ((.30-22.60) | 0.73 |
| Ward costs | 185 (89.3) | 22(10.6) | < 0.001 | 5.39 (.50-1438) | 5.22 (5.00-10.00) | 0.64 |
| Other costs | 177 (88.5) | 23(11.5) | < 0.001 | 1.95 (.24-5.34) | 1.80 (.16-350) | 0.33 |
| TOTAL | 191 (86.4) | 30 (13.5) | < 0.001 | 22.55 (5.00-54.76) | 17.22 (.16-33.70) | 0.03 |

*The number of patients whose cost of treating SMA was paid for by the healthcare provider differed significantly between the <5 years old and those ≥5 years old ($p < 0.001$). Similarly, the healthcare provider paid a significantly higher amount on treating SMA in children less than 5 years compared to the amount paid on treating the disease in children above 5 years ($p = 0.03$).*

**Table 4. Household costs and gender**

| | Gender | | | Household cost (US$) of treating SMA, Mean cost (Range) | | |
|---|---|---|---|---|---|---|
| **Items** | **Male (n,%)** | **Female (n,%)** | **p-Value** | **Male** | **Female** | **p-Value** |
| Laboratory 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 |

*Chi-square analysis was used to compare the difference between the number of female and male SMA patients who incurred the cost of treating SMA. The number of female SMA patients who bore the treatment cost was not significantly different from that of the male SMA patients ($p > 0.05$). Also, using student t-test, no significant difference between the cost incurred by the female SMA patients and the male SMA patients ($p > 0.05$) was found.*

**Table 5. Health provider costs and gender**

| **Items** | **Gender** | | | **Household cost (US$) of treating SMA, Mean cost (Range)** | | |
|---|---|---|---|---|---|---|
| | **Male (n,%)** | **Female (n,%)** | **p-Value** | **Male** | **Female** | **p-Value** |
| Laboratory 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 |

*The number of female patients whose cost of treating SMA was paid by the healthcare provider did not differ with that of the male patients ($p > 0.42$). Concerning the cost of treatment, the mean treatment cost paid by the healthcare provider did not vary significantly between the female and male SMA patients ($p > 0.26$).*

### 3.3 Provider costs

With regard to the health provider, 221 (81%) had part of the cost of treating SMA paid for by the healthcare provider. This averaged to US$ 21.83 per child. It cost 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 3).

### 3.4 Gender and Costs

Household costs were bore by 166(61.4%) males with mean cost being US$ 21.10 per child while 104 (38.5%) females incurred household costs with a mean of US$ 21.27 per child (Table 4).

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 5)

### 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 209 (77.1%) and US$ 38.44 to treat a child above 5 years, 62(22.8%) (Fig. 1).

## 4. DISCUSSION

The study aimed to find out the costs incurred by the households and government health provider in the management of a child admitted with SMA. The mean total cost (household and provider) for SMA treatment was US$ 38.83. This is slightly higher than a study in Tanzania on the economic cost of malaria in children. The study conducted in three sub-Saharan countries: Ghana,

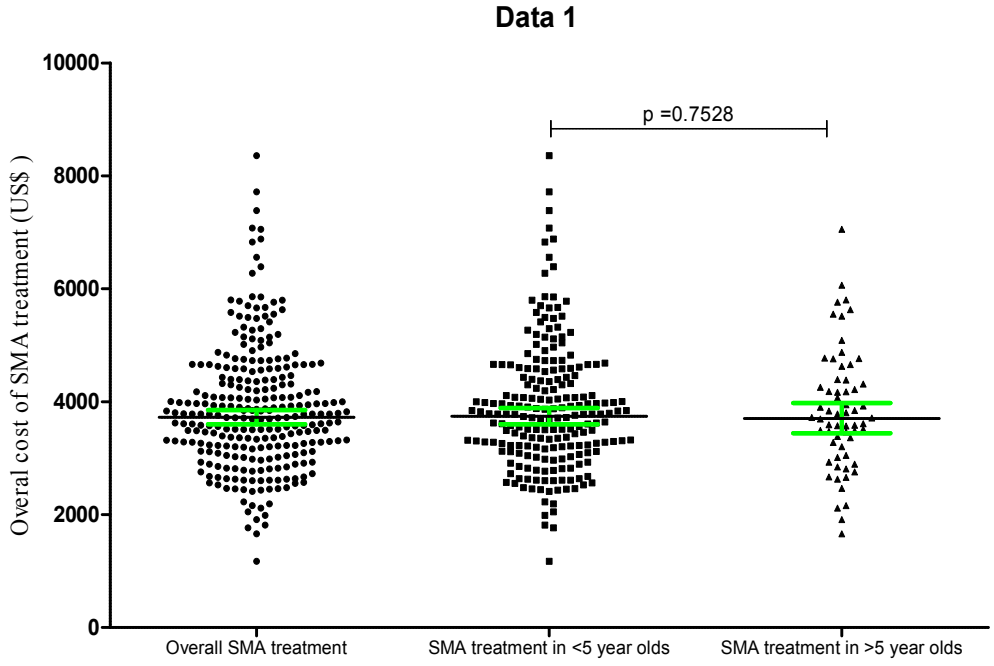


**Fig. 1. Overall cost of SMA treatment (combined data for household and provider)**

Tanzania, and Kenya revealed that Household and health system costs per malaria episode were approximately US$ 288 for complicated malaria. 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 healthcare provider. The study focused on all aspects of severe malaria while the current study only focused on SMA.

Another study by Kirigia et al. [18] showed that the unit recurrent costs per admission in Kilifi District Hospital ranged from US $57 for 'other' pediatric malaria to US $105 for cerebral malaria while at Malindi Sub-district Hospital the costs ranged from US $33 to US $44 for 'other' pediatric and cerebral malaria, respectively. This is high compared with the current study. It can be said that the costs differ substantially with the type of severe malaria.

The present study revealed that there was no much difference in the total cost of malaria treatment in a child <5 and >5 years. The mean cost of treatment of a child <5 years was US$ 38.95 and the mean cost of treatment of a child > 5 years was US$ 38.44. However the difference was found in who bore the highest cost. It was found that in children of <5 years, the provider incurred higher costs with a mean value of US$ 22.55 per child while the household incurred a lesser cost of US$18.43. For >5 years children, the household incurred higher cost with a mean value of US$ 30.08 while the provider incurred a lesser cost with a mean of US$ 17.22. These differences may be due to the fact that these services are free of charge for under 5 years children. For > 5 years children, the households meet most of the costs by themselves thus resulting in higher costs to the household and less to the care provider.

The Kenyan government through Ministry of Health financing bill, pays for both inpatient and outpatient management for under 5 years old children.[19] It would then be expected that children < 5 years would not incur any costs on drugs and laboratory tests. The study showed that children <5 paid a mean cost of US$ 5.78per child on drugs and a mean cost of US$ 6.20 on laboratory 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 laboratory tests. It was found that sometimes the hospital lacked some drugs needed for SMA treatment, thus making the parents/guardians of children <5 years to buy.

The Health financing bill supports management of diseases for the under five years old children. It would then be expected that the household meet the full cost of this treatment for the >5 years old children. 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 cost of drugs (mean cost US$ 4.07) and laboratory (mean cost US$ 9.57). On a case by case basis, the health provider would come in for the very needy children of >5 years and waive the costs incurred by the households. There was no statistically significant difference on the costs of management of SMA between male and female participants. This can be explained by the fact that management of SMA is the same for any gender and resources are allocated equally without discrimination of gender.

## 5. CONCLUSION

The mean total cost of SMA treatment was the same for children under 5 and above 5 years of age. The difference was who incurred the highest costs. The provider bore the highest cost for children under 5 and the households incurred the highest cost for children above 5 years of age. 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 level government health facilities as they also admit patients with SMA.

## 6. RECOMMENDATION

Malarial burden is high in Western Kenya. The management of Malaria and the complications of malaria such as SMA should be made free of cost for all children less than 10 years. The government together with the hospital should ensure that all the drugs and laboratory tests needed for management of malaria and its complications are always available.

The government needs to ensure that the healthcare 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 of cost.

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 in 2018 to see if there is age shift in presentations.

## CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

## ETHICAL APPROVAL

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

### DISCLAIMER

The findings and conclusions presented in this research paper 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.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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