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Determinants of Malaria Prevalence among Children below Five Years in North West Kisumu Ward, Kisumu County, Kenya: A Cross-Sectional Study

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ABSTRACT

Background: *Globally, malaria remains a major public health problem. In 2019 an estimated 229 million cases of malaria were reported, WHO African region accounted for 94% of total cases. In Kenya, malaria is a leading cause of morbidity and mortality among children under five years living in malaria endemic zones. This study investigated the factors that are associated with malaria prevalence among children under-five years living in North West Kisumu Ward, Kisumu County.*

Methods: *This cross-sectional study was carried out at Chulaimbo County Hospital from July 2019 to January 2020. Using a validated structured questionnaire, data were obtained from 369 randomly sampled children < 5 years who presented with signs and symptoms of malaria and had malaria positive or negative test results from the laboratory. Children with chronic illnesses such as HIV were not enrolled. Chi-square test of independence and logistic regression analysis was done using SPSS 20.0 software.*

Results*: Out of 369 participants, 183 (49.6%) tested positive for malaria. Child age was significantly associated with malaria (P = 0.04). There were low malaria odds among females (OR = 0.92, 95% CI 0.61-1.39) and in households where mothers (OR = 0.47, 95% CI 0.16-1.37) or fathers (OR = 0.86, 95% CI 0.31-2.35) had university education. Low malaria risk was also reported among children whose fathers had employment (OR = 0.94, 95% CI 0.49-1.80). On the contrary, high malaria risk was recorded among children whose mothers were employed (OR = 1.24, 95% CI 0.62-2.50). Children from married respondents were likely to test positive for malaria (OR = 1.07, 95% CI 0.60-1.93). Children who used bed nets were less likely to test positive for malaria (OR = 0.70, 95% CI 0.35-1.41). Surprisingly, low malaria risk was reported among severely malnourished children (OR = 0.71, 95% CI 0.42-1.20).*

Conclusion: *Child age and bed net use, but not nutritional status, are important determinants of malaria prevalence in children under 5 years. The Ministry of Health should promote more efforts towards protecting young children from malaria, by ensuring access and use of bed nets, and enhancing health education.*

Keywords: *Prevalence, Malaria, Bed nets, Nutrition, Children.*

1. Introduction

Malaria is a major public health problem globally. In 2019 an estimated 229 million cases of malaria were reported globally with the World Health Organization (WHO) African region accounting for about 94% of the total cases [1]. In Kenya, one in twelve children (84 per 1000 live birth) die before their fifth birth day, with malaria being the leading cause of death in children under the age of five years in malaria endemic zones [2].

Despite all the efforts in place to control malaria such as chemotherapy, use of insecticide treated bed nets and health education, malaria still remains a major public health problem with children under the age of five years being the most affected. Studies conducted to investigate how age influences malaria transmission among children under the age of five years have reported contradicting results. While some studies have reported that malaria prevalence is high among children below the age of one year, other studies have reported that children above 2 years were more likely to develop malaria infection than those below 2 years [3-4].

In addition, the relationship between gender and malaria prevalence among children below the age of five years remain unclear. Previous studies conducted in sub-Saharan Africa have reported seasonal variation in malaria prevalence among boys and girls under the age of five years [5]. The information on the relationship between gender and malaria prevalence among children under the age of five years still remain unclear thus the need to conduct this study to help understand this relationship. Educational status and occupation of a parent/guardian are important determinants of under-five malaria morbidity. Educational status of a parent/guardian informs the level of awareness of the parent to health matters, helps them make informed health decisions and choices. Educated parents are likely to get well-paying jobs hence adequate resources to access quality health care. On the contrary, less educated people are likely to engage in activities which bring little income hence poor health [4]. The relationship between parental educational status and under-five malaria prevalence in North West Kisumu Ward has not been investigated hence the need for the study. Insecticide treated bed nets reduces malaria infection and deaths by forming a protective barrier against the malaria causing vector [6]. The use of WHO recommended long lasting insecticide-treated mosquito nets for every two people forms an important component of malaria control and elimination strategies [7]. Insecticide treated bed nets have shown to reduce malaria episodes by 50% and under five mortality by 17%, several studies conducted in sub-Saharan Africa have also demonstrated community wide benefits of insecticide treated bed nets on malaria related morbidity and mortality [8].

In Kenya, the universal coverage of one net for every two people was realized in 2012 [9]. The usage of bed nets among children under the age of five years living in North West Kisumu Ward has not been assessed hence the need to conduct the study. A study conducted in Siaya, Western Kenya, involving children between 0-35 months of age reported that malaria and under nutrition were related such that undernourished children experienced more malaria and malaria related morbidity [10]. However, this study did not involve children older than 35 months. To clearly understand the relationship between nutritional status and malaria morbidity among children under the age of five years, this study included all the age groups within the first five years of life.

2. Methods

Study site and study design

The study was conducted at Chulaimbo County Hospital in North West Kisumu Ward in Kisumu County, Kenya. It is a malaria endemic zone. In 2019, Chulaimbo hospital catchment area population was approximately 21, 452 people, children < 5 years were about 3623 (16.9 %) of total population. The facility predominantly serves the rural population of North West Kisumu Ward. Economic activities engaged by the people of this region include small scale farming and business. A descriptive cross-sectional design was used due to its relevance in estimating prevalence and measuring both outcome and exposure variables simultaneously.

Target and study population

This study targeted children under the age of five years who sought treatment at Chulaimbo County hospital. Those who had signs and symptoms of malaria such as vomiting and fever ≥ 37.5 ℃, tested positive or negative for malaria and residents of North West Kisumu ward for at least one month were consented to participate in the study. Those who had chronic illnesses such as HIV were excluded from the study.

Data collection

Structured questionnaire was used to collect the participant's socio-economic and demographic data. Information on bed net usage characteristics and child anthropometric body measurements were also collected.

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Sample size and sampling procedure

The formulae used to calculate the sample size was adapted from Charan and Biwas [11]. The formula is useful in calculating sample size for cross sectional studies. The sample size was calculated based on under five malaria prevalence of 40% as per the 2017 District Health Information System (DHIS) [12], a 95% confidence level and a 5% precision. The final sample size was 369. Simple random sampling was applied. The potential participants from the laboratory were identified, informed about the study, consented and enrolled. The participants were then triaged where temperature, weight, height/length and mid upper arm circumference were taken. Temperature was taken in degrees Celsius by use of digital clinical thermometer manufactured by Omron (ref: 20140411 UF), weight was taken in kilograms by use of digital weighing scale manufactured by Omron (ref: 20141202445) and Seca (ref: 8354091180468), height/length in centimeters by use of height/length measuring scale made by Seca (ref: 0123).

Statistical analysis of data

Data from the questionnaires was entered into Microsoft excel, cleaned and checked for completeness. The child anthropometric measurements were entered into WHO Anthro plus calculator to calculate the child's weight for height and height for age nutritional status. The data were then analyzed using Statistical Package for Social Sciences (SPSS) version 20. Validation and quality assurance checks were done to ensure the integrity of data. Questionnaires were uniquely numbered to help track and match the questionnaires against the computer entries. Chi square test of independence was used to determine the association between the dependent and independent variables. Crude Odds ratios (c*OR*) was calculated to test various exposures for associations with the outcome variable. Most recent studies have used variables significant at $p<0.2$ at the multivariable level hence in this study exposures with p-Value <0.2 was included into the multiple logistic regression model using either backward or forward selection process for the calculation of adjusted odds ratios (a*OR*) in which, all exposures with p-value <0.05 was considered to be independently associated with the malaria prevalence.

3. Results

A total of 369 children under the age of five years were enrolled in this study. The general characteristics of the study participants are summarized in Table 1. One hundred and fourteen (30.9%) were between the age of 0-12 months, ninety three (25.2%) of these children were between the age of 13-24 months, seventy three (19.8%) were aged between 25-36 months and 56 (15.2%) were aged between 37-48 months. Of the 369 respondents, only 33 (8.9%) were aged between 49-60 months old. Majority were male (53.7%) with females accounting for 46.3%. More than three quarter (91.6%) of the children were brought to the clinic by their mothers. Twenty (5.4%) of the children were brought to the clinic by care givers. The mean age of the children was 24.66 months.

One hundred and eighty-nine mothers (51.2%) and 142 (38.5%) fathers in this study had primary level of education. In general, 128 (34.7%) both mothers and fathers had secondary level of education and only 33 (8.9%) mothers and 38 (10.3%) fathers had a higher level of education (Table 1). Overall, 277 (75.1%) mothers and 248 (67.2%) fathers were in private business while 36 (9.8%) mothers and 43 (11.7%) of fathers were employed. On the other hand, 56 (15.2%) mothers and 78 (21.1%) fathers did not report any source of income. The highest number (n=317; 85.9%) of the respondents were married and only 52 (14.1%) of them were single parents. One hundred and eighty four (49.9%) and 166 (45.0%) of the children had normal nutritional status for weight for height and height for age respectively (Table 1).

Table 1. Socio-economic, Demographic and Nutritional characteristics of study participants (N=369)

Characteristics	n (%), Mean±SD
Age of the child (months)	24.66±15.89
Age category (months)	
0-12	114 (30.9)
13-24	93 (25.2)
25-36	73 (19.8)
37-48	56 (15.2)
49-60	33 (8.9)
Gender of the child	
Male	198 (53.7)
Female	171 (46.3)
Relationship with child	
Mother	338 (91.6)
Father	11 (3.0)
Care giver	20 (5.4)
Mother's Education level	
Primary	189 (51.2)
Secondary	128 (34.7)
College/University	33 (8.9)
Never attended school	19 (5.2)
Father's Education level	
Primary	142 (38.5)
Secondary	128 (34.7)
College/University	38 (10.3)
Never attended school	61 (16.5)
Mother's Occupation status	
Self employed	277 (75.1)
Employed	36 (9.7)
Not employed	56 (15.2)
Fathers' Occupation status	
Self employed	248 (67.2)
Employed	43 (11.7)
Not employed	78 (21.1)
Marital status	
Single	52 (14.1)
Married	317 (85.9)
Weight for height nutritional status	
Normal nutritional status	184 (49.9)
Moderate wasting	115 (31.1)
Severe wasting	70 (19.0)

Height for age nutritional status	
Normal nutritional status	166 (45.0)
Moderate stunting	101 (27.4)
Severe stunting	102 (27.6)

Weight for height nutritional status-measures wasting; Height for age nutritional status-measures stunting; SD: Standard Deviation

Out of the 333 (90.2%) bed nets available (Table 2), 331 (89.7%) of them were used by the children and a bigger percentage 321 (87.0%) were issued from the hospital while the remaining 12 bed nets, were bought from shops or issued in the community. Most of the bed nets (89.2%) were treated, 208 (56.4%) were aged between 0-12 months. Majority were blue in color 325 (88.1%) and 331 (89.1%) were rectangular in shape.

Table 2. Bed net usage characteristics

Bed Net Characteristics	All N=369 n (%)
Bed net availability	
Yes	333 (90.2)
No	36 (9.8)
Source of bed net†	
Hospital	321 (87.0)
Community	6 (1.6)
Shop	6 (1.6)
Bed net used by participant†	
Yes	331 (89.7)
No	2 (0.5)
Age of bed net (months)†	
0-12	208 (56.4)
13-24	87 (23.6)
25-36	35 (9.5)
Treated bed nets†	
Yes	329 (89.2)
No	2 (0.5)
Retreated bed nets†	
Yes	11 (3.0)
No	320 (86.7)
Colour of the bed net†	
Blue	325 (88.1)
White	2 (0.5)
Green	4 (1.1)
Shape of the bed net†	
Rectangle	331 (89.1)
Condition of the bed net†	
Torn	95 (25.8)
Not torn	236 (64.0)
Time of sleeping in bed net†	
All time when asleep	98 (26.6)
At night	208 (56.4)

† Variables with missing cases; S.D Standard Deviation.

Only 11 (3.0%) of the bed nets were retreated. Of these 333 available nets, 95 (25.8%) were torn. Over half of the children 208 (56.4%) slept under the nets at night while 98 (26.6%) slept under their nets all the time when sleeping. Age was significantly associated with malaria prevalence among children under the age of five years (*P* = 0.04). However, this analysis did not detect any significant association between gender of the child and malaria prevalence (*P* = 0.71). This study also compared malaria prevalence and marital status and reports no association (*P* = 0.81). No significant association were observed in maternal education (*P* = 0.09), education status of the father (*P* = 0.22), mother's occupation (*P* = 0.26) and occupation of the father (*P* = 0.39) (Table 3).

Table 3. Socio-economic and demographic characteristics of the study participants

Demographic Variables	All N=369 n (%),	Malaria Positive N=183 n (%),	Malaria Negative N=186 n (%),	p-Value
Age category (months)				
0-12	114 (30.9)	43 (23.5)	71 (38.2)	
13-24	93 (25.2)	50 (27.3)	43 (23.1)	
25-36	73 (19.8)	38 (20.8)	35 (18.8)	**0.04**[a]
37-48	56 (15.2)	34 (18.6)	22 (11.8)	
49-60	33 (8.9)	18 (9.8)	15 (8.1)	
Gender of the child				
Male	198 (53.7)	100 (54.6)	98 (52.7)	0.71
Female	171 (46.3)	83 (45.4)	88 (47.3)	
Relationship with child				
Mother	338 (91.6)	163 (89.1)	175 (94.1)	
Father	11 (3.0)	8 (4.4)	3 (1.6)	0.18
Care giver	20 (5.4)	12 (6.5)	8 (4.3)	
Mother's Education level				
Primary	189 (51.2)	102 (55.7)	87 (46.8)	
Secondary	128 (34.7)	62 (33.9)	66 (35.5)	0.09
College/University	33 (8.9)	10 (5.5)	23 (12.3)	
attended school	19 (5.2)	9 (4.9)	10 (5.4)	
Father's Education level				
Primary	142 (38.5)	78 (42.6)	64 (34.4)	
Secondary	128 (34.7)	63 (34.4)	65 (35.0)	0.22
College/University	38 (10.3)	14 (7.7)	24 (12.9)	
Never attended school	61 (16.5)	28 (15.3)	33(17.7)	
Mother's Occupation status				
Self employed	277 (75.1)	131 (71.6)	146 (78.5)	
Employed	36 (9.7)	19 (10.4)	17 (9.1)	0.26
Not employed	56 (15.2)	33 (18.0)	23 (12.4)	
Father's Occupation status				
Self employed	248 (67.2)	119 (65.0)	129 (69.3)	
Employed	43 (11.7	20 (11.0)	23 (12.4)	0.39
Not employed	78 (21.1)	44 (24.0)	34 (18.3)	
Marital status				
Single	52 (14.1)	25 (13.7)	27 (14.5)	0.81
Married	317 (85.9)	158 (86.3)	159 (85.5)	

[a]Significant p-Values at p<0.05; SD: Standard Deviation

From the univariate analyses, we found that children aged between 13-24 months old (*OR* = 1.92, 95% *CI* 1.10-3.35) or 37-48 months (*OR* = 2.55, 95% *CI* 1.32-4.92) were significantly more likely to test positive for malaria as compared to those who were less than 13 months old (Table 4). However, age between 25-36 months (*OR* = 1.79, 95% *CI* 0.99-3.25) and 49-60 months (*OR* = 1.98, 95% *CI* 0.91-4.33) were associated with higher odds but insignificant effects ($P > 0.05$). The same case was observed among children related to care givers (*OR* = 1.61, 95% *CI* 0.64-4.04) or those living with their fathers (*OR* = 2.86, 95% *CI* 0.75-10.98). Employment was associated with higher odds of testing positive for malaria such that children from mothers who had no employment (*OR* = 1.60, 95% *CI* 0.89-2.86) or were employed (*OR* = 1.24, 95% *CI* 0.62-2.50) were more likely to have Malaria as compared to mothers who were self-employed though the effect was not statistically significant. Gender and parental education were associated with reduced odds of predicting malaria in this study such that female children were less likely to test positive for malaria (*OR* = 0.92, 95% *CI* 0.61-1.39) as compared to their male counterparts and children from mothers or fathers who had secondary education and above were less likely to test positive for malaria as compared to children whose mothers or fathers had primary level of education. At the multivariate analysis, only children aged between 13-24 months (*OR* = 1.84, 95% *CI* 1.03-3.29, $P = 0.04$) or those aged between 37-48 months (*OR* = 2.29, 95% *CI* 1.16-4.52, $P = 0.02$) remained significantly associated with having malaria (Table 4).

Table 4. Socioeconomic and demographic predictors of malaria prevalence

Predictors	Malaria Positive N=183 n (%)	Malaria Negative N=186 n (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	p-Value
Age category (months)					
0-12	43 (23.5)	71 (38.2)	Ref		
13-24	50 (27.3)	43 (23.1)	1.92 (1.10,3.35)	1.84 (1.03,3.29)	**0.04**
25-36	38 (20.8)	35 (18.8)	1.79 (0.99,3.25)	1.62 (0.87,3.01)	0.13
37-48	34 (18.6)	22 (11.8)	2.55 (1.32,4.92)	2.29 (1.16,4.52)	**0.02**
49-60	18 (9.8)	15 (8.1)	1.98 (0.91,4.33)	1.77 (0.78,4.02)	0.17
Gender of the child					
Male	100 (54.6)	98 (52.7)	Ref		
Female	83 (45.4)	88 (47.3)	0.92 (0.61,1.39)		
Relationship with child					
Mother	163 (89.1)	175 (94.1)	Ref		
Father	8 (4.4)	3 (1.6)	2.86 (0.75,10.98)	2.18 (0.55,8.63)	0.27
Care giver	12 (6.5)	8 (4.3)	1.61 (0.64,4.04)	1.91 (0.65,5.58)	0.24
Mother's Education level					
Primary	102 (55.7)	87 (46.8)	Ref		
Secondary	62 (33.9)	66 (35.5)	0.80 (0.51,1.26)	0.96 (0.57,1.60)	0.87
College/University	10 (5.5)	23 (12.3)	0.37 (0.17,0.82)	0.47 (0.16,1.37)	0.17
Never attended school	9 (4.9)	10 (5.4)	0.77 (0.30,1.97)	0.65 (0.21,2.03)	0.46
Father's Education level					
Primary	78 (42.6)	64 (34.4)	Ref		

Secondary	63 (34.4)	65 (35.0)	0.80 (0.49,1.28)	0.89 (0.52,1.53)	0.69
College/University	14 (7.7)	24 (12.9)	0.48 (0.23,1.00)	0.86 (0.31,2.35)	0.77
Never attended school	28 (15.3)	33(17.7)	0.70 (0.38,1.27)	0.72 (0.34,1.50)	0.38
Mother's Occupation status					
Self employed	131 (71.6)	146 (78.5)	Ref		
Employed	19 (10.4)	17 (9.1)	1.24 (0.62,2.50)		
Not employed	33 (18.0)	23 (12.4)	1.60 (0.89,2.86)		
Father's Occupation status					
Self employed	119 (65.0)	129 (69.3)	Ref		
Employed	20 (11.0)	23 (12.4)	0.94 (0.49,1.80)		
Not employed	44 (24.0)	34 (18.3)	1.40 (0.84,2.34)		
Marital status					
Single	25 (13.7)	27 (14.5)	Ref		
Married	158 (86.3)	159 (85.5)	1.07 (0.60,1.93)		

[a]Variables that were significant at p<0.2 were included in the multivariate model, Ref- Reference group, CI-Confidence Intervals; cOR: Crude Odds Ratio

Bed net usage characteristics and malaria prevalence

There was no significant relationship between bed net availability and malaria prevalence (P = 0.32). In addition, this study did not report any significant relationship between the source of the bed net and malaria prevalence (P = 0.19). Whether the child sleeps under the bed net or not was not associated whatsoever with testing positive for malaria (P = 0.50). This study also did not report significant relationship between age of bed net and child testing positive for malaria (P = 0.10). Similar results were reported for color of the bed net (P = 0.61), condition of the bed net (P = 0.19) and time of sleeping under the bed net (P = 0.05) (Table 5)

Table 5. Bed net usage characteristics and malaria prevalence

Bed net Characteristics	All N=369 n (%)	Malaria Positive N=183 n (%)	Malaria Negative N=186 n (%)	p-Value
Bed net availability				
Yes	333 (90.2)	168 (91.8)	165 (88.7)	0.32
No	36 (9.8)	15 (8.2)	21 (11.3)	
Source of bed net				
Hospital	321 (87.0)	161 (88.0)	160 (86.0)	
Community	6 (1.6)	2 (1.1)	4 (2.2)	0.19
Shop	6 (1.6)	5 (2.7)	1 (0.5)	
Bed net used by participant				
Yes	331 (89.7)	166 (90.7)	165 (88.7)	0.50
No	2 (0.5)	2 (1.1)	0	
Age of bed net (months)				
0-12	208 (56.4)	97 (53.0)	111 (59.7)	0.10

13-24	87 (23.6)	46 (25.1)	41 (22.0)	
25-36	35 (9.5)	23 (12.6)	12(6.5)	
Treated bed nets				
Yes	329 (89.2)	165 (90.2)	164 (88.2)	0.75
No	2 (0.5)	1 (0.6)	1 (0.5)	
Retreated bed nets				
Yes	11 (3.0)	6 (3.3)	5 (2.7)	0.75
No	320 (86.7)	160 (87.4)	160 (86.0)	
Colour of bed net				
Blue	325 (88.1)	162 (88.5)	163(87.6)	
White	2 (0.5)	1 (0.6)	1 (0.5)	0.61
Green	4 (1.1)	3 (1.6)	1 (0.5)	
Shape of bed net				
Rectangle	331 (89.1)	166 (90.7)	165 (88.7)	N/A
Condition of bed net				
Torn	95 (25.8)	53 (29.0)	42 (22.6)	0.19
Not torn	236 (64.0)	113 (61.8)	123 (66.1)	
Time of sleeping in bed net				
All time	98 (26.6)	42 (23.0)	56 (30.1)	0.05
At night	208 (56.4)	114 (62.3)	94 (50.5)	

This analysis used Chi-squared or Fisher exact when appropriate, N/A Variables that did not meet conditions for Chi-square test due to missing data in some groups.

From the univariate analyses of bet net data, we found that children who used bed nets aged 25-36 months old (*OR* = 2.19, 95% *CI* 1.04-4.64) were significantly more likely to test positive for Malaria. This was also the case for children who slept under bed nets only at night (*OR* = 1.62, 95% *CI* 1.00-2.62) .Children who used bed nets aged between 13-24 months old (*OR* = 1.28, 95% *CI* 0.78-2.12), used bed nets from shops (*OR* = 4.97, 95% *CI* 0.57-43.01) , slept under untreated bed nets (*OR* = 2.01, 95% *CI* 0.18-22.41), used green bed nets (*OR* = 3.04, 95% *CI* 0.31-29.51) or white bed nets (*OR* = 1.01, 95% *CI* 0.06-16.32) were found to be associated with increased odds of testing positive for Malaria, though the effects were not statistically significant ($P > 0.05$) (Table 6). Children who did not use torn nets (*OR* = 0.73, 95% *CI* 0.45-1.18), had bed nets (*OR* = 0.70, 95% *CI* 0.35-1.41), used community nets (*OR* = 0.50, 95% *CI* 0.09-2.75) were not associated with having Malaria. However, after adjusting for other covariates, using bed nets aged 25-36 months old (*OR* = 2.04, 95% *CI* 0.87-4.77) and sleeping under bed nets only at night (*OR* = 1.46, 95% *CI* 0.87-2.44) did not have a positive association with Malaria, though associated with increased odds. Children who slept under bed nets that were not torn (*OR* = 0.90, 95% *CI* 0.52-55), those used community nets (*OR* = 0.57, 95% *CI* 0.10-3.22) remained less likely to get malaria infection (Table 6).

Table 6. Bed Net Predictors of Malaria Prevalence

Predictors	Malaria Positive N=183 n (%)	Malaria Negative N=186 n (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	p-Value
Bed net availability					
Yes	168 (91.8)	165 (88.7)	Ref		
No	15 (8.2)	21 (11.3)	0.70 (0.35,1.41)		

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Source of bed net					
Hospital	161 (88.0)	160 (86.0)	Ref		
Community	2 (1.1)	4 (2.2)	0.50 (0.09,2.75)	0.57 (0.10,3.22)	0.52
Shop	5 (2.7)	1 (0.5)	4.97 (0.57,43.01)	4.74 (0.53,42.23)	0.16
Bed net used by participant					
Yes	166 (90.7)	165 (88.7)	N/A		
No	2 (1.1)	0			
Age of bed net (months)					
0-12	97 (53.0)	111 (59.7)	Ref		
13-24	46 (25.1)	41 (22.0)	1.28 (0.78,2.12)	1.15 (0.66,2.02)	0.63
25-36	23 (12.6)	12(6.5)	2.19 (1.04,4.64)	2.04 (0.87,4.77)	0.10
Treated bed nets					
Yes	165 (90.2)	164 (88.2)	Ref		
No	1 (0.6)	1 (0.5)	2.01 (0.18,22.41)		
Retreated bed nets					
Yes	6 (3.3)	5 (2.7)	Ref		
No	160 (87.4)	160 (86.0)	0.83 (0.25,2.79)		
Colour of bed net					
Blue	162 (88.5)	163(87.6)	Ref		
White	1 (0.6)	1 (0.5)	1.01 (0.06,16.32)		
Green	3 (1.6)	1 (0.5)	3.04 (0.31,29.51)		
Shape of bed net					
Rectangle	166 (90.7)	165 (88.7)	N/A		
Condition of bed net					
Torn	53 (29.0)	42 (22.6)	Ref		
Not torn	113 (61.8)	123 (66.1)	0.73 (0.45, 1.18)	0.90 (0.52,55)	0.71
Time of sleeping in bed net					
All time	42 (23.0)	56 (30.1)	Ref		
At night	114 (62.3)	94 (50.5)	1.62 (1.00,2.62)	1.46 (0.87,2.44)	0.15

N/A: Variables with missing cases hence odds ratios and CI were not computed

Nutritional status and malaria prevalence among children under the age of five years

Malnutrition generally increases an individual's susceptibility to infections. Malnutrition among children from Chulaimbo was approximated to be 50.1%.

Weight for height and height for age was used to asses' child nutritional status. Weight for height measures wasting while height/length for age measures stunting.

Wasting is a symptom of acute under nutrition and is defined as <- 2 SD of WHO Child Growth Standard median. Stunting is a symptom of chronic under nutrition and is defined as <-2 SD of WHO Child Growth Standard median. Normal nutritional status was defined as -1 SD to +1 SD of WHO Child Growth Standard median.

As shown in (Table 7), neither weight for height nutritional status ($P > 0.06$) nor did height for age nutritional status ($P > 0.11$) have significant association with malaria prevalence.

Table 7. Nutritional status and malaria prevalence

Nutritional status	All N=369 n (%)	Malaria Positive N=183 n (%)	Malaria Negative N=186 n (%)	p-Value
Weight for height nutritional status				
Normal nutritional status	184 (49.9)	91 (49.7)	93 (50.0)	
Moderate wasting	115 (31.2)	65 (35.5)	50 (26.9)	0.06
Severe wasting	70 (18.9)	27 (14.8)	43 (23.1)	
Height for age nutritional status				
Normal nutritional status	166 (45.0)	85 (46.4)	81 (43.5)	
Moderate stunting	101 (27.4)	56 (30.6)	45 (24.2)	0.11
Severe stunting	102 (27.6)	42 (23.0)	60 (32.3)	

[a]Significant p-Values at p<0.05; Moderate wasting/stunting- < -2 SD to -3 SD; Severe wasting/stunting- < - 3 SD

4. Discussions

Despite all the interventions put in place to prevent and control malaria prevalence among children under the age of five years living in malaria endemic settings, malaria still remains a major public health problem among children under five years. This study sought to demonstrate the relationship between socio-economic, demographic factors and malaria prevalence. Child's age was significantly associated with malaria prevalence among children under the age of five years, however it did not demonstrate any significant association between malaria and other variables. This study as well sought to demonstrate the relationship between bed net usage characteristics, child nutritional status and malaria prevalence and found no significant association.

This study observed that children who were aged between 13-24 months old, 25-36 months, 37-48 months and 49-60 months old were more likely to test positive for malaria as compared to those who were less than 13 months old. This finding is in line with that of a previous study that reported that, children above 2 years of age are more likely to get malaria infection than those below 2 years [4].

The susceptibility of children over two years of age to malaria infection could be attributed to reduced maternal antibodies that protects against malaria infection and also due to the fact that children above two years of age were active and could be playing outdoors late in the evening when mosquitoes which transmit malaria are at the peak of their biting habit [13,14]. This study also observed that female children were less likely to test positive for malaria as compared to their male counterparts. This is in agreement with that of a study conducted in Ethiopia that reported that, malaria cases were high among males than females [15]. This is because female children are less biologically vulnerable to infectious diseases than males [16]. This study further reported that, children from mothers or fathers who had secondary level of education and above were less likely to test positive for malaria as compared to children whose parents had primary level of education. Similar finding was reported from a study conducted in Uganda where a decreasing trend of malaria prevalence was reported among children below the age of five years whose mothers had the highest level of education [17]. This is perhaps due to the fact that well-educated parents have high level of awareness on health care and wellbeing.

This study also observed that children whose mothers were employed and those whose mothers were not employed had higher odds of getting malaria as compared to those whose mothers were self-employed. Moreover, children whose fathers were employed were less likely to test positive for malaria as compared to those whose fathers were not employed, this could be attributed to the fact that employment provide source of income hence higher chances of seeking proper health services. However, our findings contradict that of a study conducted in Tanzania that reported that, individual's socioeconomic status was not associated with malaria risk when malaria was a dependent variable [18]. Mothers who are employed could be busy with their employment thereby disregarding malaria prevention and control measures hence increased malaria odds. On the other hand, unemployed mothers could be lacking source of income hence impaired ability to provide proper health services. Finally, this study reported that, children from married respondents had increased odds of getting malaria as compared to children from single parents. This however contradicts findings from another study conducted in Ethiopia that associated households headed by single parents with poor health services [19]. These observations can be attributed to the fact that households with married respondents are likely to have big family size which is likely to strain the financial ability of the family making the family unable to bear the expenses associated with taking preventive measures against malaria [20].

Bed net usage reduces malaria morbidity and mortality by providing barrier between people sleeping under them and mosquitoes. To demonstrate this relationship, this study evaluated the bed net usage characteristics and malaria prevalence. The analysis demonstrated that children who had bed nets were less likely to test positive for malaria as compared to those who did not have bed nets. This is similar to findings of a study conducted in Democratic Republic of Congo which reported low malaria risk among children who used bed nets [21]. This findings is due to the fact that bed nets provide protection against mosquito bites, thereby reducing individual's chances of getting malaria [9]. This study also reported that children who used bed nets bought from shops were more likely to test positive for malaria than those who used bed nets from the community and hospital.

This observation was surprising, however this is perhaps due to the fact that bed nets from the community/ or hospital are long lasting treated mosquito bed nets provided by ministry of health and therefore provide better protection from mosquito bites as compared to the ones bought from the shops [9]. It was further revealed that children who slept under untreated bed nets had increased odds of testing positive for malaria as compared to children who slept under treated bed nets. This observation is similar to those of previous studies that reported that, children who slept under untreated bed nets had increased odds of getting malaria [7, 21, 22]. This observation is due to the fact that Insecticide treated bed nets repel or kill mosquitoes attempting to feed upon humans sleeping in them thereby reducing chances of mosquito bite. However this findings contradicts that of a study conducted in Uganda that reported increased malaria odds among children who used long lasting insecticide treated bed nets and the compliance with the bed net use was 98% [23]. This study further reported that, children who used torn bed nets had higher odds of getting malaria as compared to children who slept under nets that were not torn, this is due to the fact that torn bed nets exposed children to mosquito bite as they allow mosquitos into the nets to bite people sleeping under the nets. Finally, this analysis demonstrated that children who slept under bed nets only at night were significantly associated with having malaria than those who used the nets all the time. Sleeping under bed net all the time provided optimal protection from mosquito bite thereby reduced malaria infection.

The relationship between malnutrition and malaria is complex. Previous studies reported that malnutrition had protective effect against malaria while new studies have reported that malnutrition increases the risk of malaria infection. Some studies have however reported no association between malnutrition and malaria. To understand this relationship in North West Kisumu Ward which is a high malaria transmission zone, this study analyzed child nutritional status and malaria prevalence. Surprisingly, results from this study demonstrate that children who had severe wasting or stunting were less likely to have malaria as compared to those with normal nutritional status. This is in line with finding from a study conducted in Senegal that reported that, malaria odds were low among the severely malnourished preschool children [24]. Similarly, a study conducted in rural settings in the Brazilian Amazon demonstrated reduced malaria odds among malnourished children [25]. The finding from this study can be attributed to non-biological explanations such as overprotection of severely malnourished children from their mothers [24] or perhaps due to severe malnutrition apathy which is a state of inactive which is likely to make such children less playful hence reduced chances of staying outdoors late in the evening when malaria transmitting vectors are at the peak of their biting habit [14].

This finding is however challenged by a study conducted in Ethiopia that demonstrated high malaria odds among severely wasted children under the age of five years [26]. Another study conducted in Democratic Republic of Congo also demonstrated that malaria odds were high among severely malnourished children who were below the age of five years [27]. Similarly, a study conducted in Uganda reported an increased malaria risk among severely malnourished children [28]. Other studies conducted elsewhere in malaria hot spots have equally reporeted high malaria risk among severly malnourished children [10,29]. Malnutrition result to impared ability of malnourished children to mount effective immune response when exposed to pathogens by resulting in a reduction in T lymphocyte count, including Tcell subsets, and, thus in decreased numbers of effector cells and decreased formation of cytokines which are important for parasite clearence. In addition, there is increasing evidence that antibody and complement formation is mediated by nutritional status [30].

A study conducted in Ethiopia however demonstrated that there is no association between malnutrition and increased malaria risk [31]. Another study conducted in South West Ethiopia also demonstrated that there is no association between malnutrition and malaria [32]. Similarly, a study conducted in Sierra Leone reported no association between severe malnutrition and increased malaria odds [33]. In addition, a study conducted in rural Gambia and West Africa reported that there is no association between stunting and increased malaria incidence [34, 35]. Other studies conducted to determine the relationship between malnutrition and malaria incidence have however demonstrated mixed results. An epidemiological study conducted in Niger demonstrated mixed association between malnutrition and under five malaria prevalence with stunting an indicator of chronic malnutrition being associated with both increased and decreased malaria prevalence [36]. The source of conflicting results for studies of malnutrition and malaria still remain unclear. There may be differences due to differences in populations under study, immunity and or differences in metrics used in studies that contribute to heterogeneity in results. The study design suffered recall bias. Some participants were not able to recall information required from them, so in such cases, the information required was obtained from the hospital records department from under-fives who had been previously treated at Chulaimbo hospital, this was done after permission had been granted by the hospital in charge.

5. Conclusion

Child age and bed net use, but not nutritional status, are important determinants of malaria prevalence in children under 5 years. The Ministry of Health should promote more efforts towards protecting young children from malaria, by ensuring access and use of bed nets, and enhancing health education.

6. Recommendations

Additional malaria preventive measures combined with implemented strategies should be put in place for children above 13 months of age as this is a much more vulnerable group. In addition, health education on malaria preventive measures should be strengthened to increase malaria prevention awareness. Children under the age of five years should sleep under long lasting insecticide treated bed nets provided by the ministry of health throughout for better protection from mosquito bite.

7. List of Abbreviations

aOR: Adjusted Odds Ratio

cOD: Crude Odds Ratio

HIV: Human Immunodeficiency Syndrome

MOH: Ministry of Health

MUAC: Mid Upper Arm Circumference

SPSS**:** Statistical package for Social Sciences

SD: Standard Deviation

WHO: World Health Organization

Declarations

Ethical consideration

Ethical clearance and approval to conduct this study was sought from the Board of Postgraduate Studies, JOOUST. Ethical approval of the study was obtained from University of Eastern Africa, Baraton Research Ethics Committee. Informed consent was given by the mothers/guardians before their children were enrolled into the study.

Availability of data and Materials

The dataset used/or analyzed during this study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Author's Contributions

Midem David conceived the study, wrote the original draft, collected and analyzed data and prepared final manuscript; Dr. Daniel Onguru and Babu Lawrence were involved in study design, implementation and statistical analysis. All authors read and approved the final draft.

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