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Factors Associated with Malaria Transmission: A Comparative Study of Munyumbwe and Sompani Rural Health Centres in Gwembe District - February 2020

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Abstract: Background: Malaria remains a major public health problem in Zambia. Malaria hotspots pose a challenge to attaining malaria elimination by 2021. Identifying predictors of malaria in hotspots and geographically adjacent areas might reveal important information about how to achieve this goal. Munyumbwe and Sompani Rural Health Centres (RHCs) in Southern Province have been receiving the same intervention package since 2014, yet malaria incidence in 2019 were 6/1000 and 117/1000, respectively. This study aimed at investigating factors associated with malaria transmission in these two RHC catchment areas. Methods: A cross-sectional study was undertaken at Munyumbwe and Sompani RHCs, where a pre-tested structured questionnaire was administered to 340 consenting participants tested for malaria during January-February 2020. Data collected included: age; education level; malaria knowledge; insecticide treated nets (ITN) possession and use; indoor residual spraying (IRS); travel history; index case follow-up; outdoor activities; and presence of stagnant water. Multiple logistic regression analysis was done using Stata. Results: At Sompani RHC, 50% (85/170) of participants had malaria during January-February 2020 compared to Munyumbwe with 5.9% (10/170). The study also showed that respondents from Munyumbwe RHC had 80% reduced chance of acquiring malaria compared to those from Sompani (AOR = 0.2; p = 0.001). Travelling outside the district was associated with malaria (AOR = 29.48; p < 0.0001) only at Sompani RHC. In both areas, participants who utilized ITNs had reduced odds of acquiring malaria than those who never utilized (AOR = 0.28 p = 0.04), (AOR=0.11 p = 0.006) at Munyumbwe and Sompani RHC respectively. Index case follow-up was lower in Sompani (6%) than Munyumbwe (90%) (p < 0.0001). Furthermore, the ratio of Community Health workers to the catchment population for Munyumbwe and Sompani RHCs were 1:500 and 1:1250 respectively. Conclusion: Travelling outside the district was a unique predictor of malaria. Additionally, only a minority of index cases is followed up in Sompani, in contrast to Munyumbwe due to inadequate number of CHWs. Providing malaria prophylaxis to travelers, training CHWs and strengthening index case follow-up are potential strategies to control malaria in Sompani and Munyumbwe.

Keywords: Malaria, Malaria Transmission, Intervention Package, Vision

1. Introduction

Malaria has plagued mankind throughout history and remains one of the major challenges to global public health. The disease contributes a considerable burden in endemic countries with premature deaths, disability from illness and it impedes on social and economic development [1]. According

to the World Malaria Report 2018 [2], the global burden of the disease in 2017 was estimated at 219 million cases and 435 000 deaths worldwide, with the African region accounting for 92% of the cases and 93% of the deaths.

Zambia has four types of *Plasmodium* parasites that can cause malaria in humans: (1) *P. falciparum*, (2) *P. malariae*, (3) *P. vivax*, and (4) *P. ovale*. Out of these, *Plasmodium falciparum* accounts for 98% of all infections. The Malaria incidence rate (confirmed and clinical cases) in Zambia as reported in the 2018 Health Management Information System (HMIS) report stands at 311 per 1000 population; a decrease from 374 per 1000 population reported in 2017 The estimated number of In-patient malaria deaths stood at 15.5 per 100,000 persons per year [3].

Malaria transmission in Zambia occurs year-round with peak transmission during the rainy season, between November and April but it varies across climatic seasons, ecological zones, neighboring villages, and even between neighboring households [4]. The variation of the incidence rate of malaria is also seen across all the provinces of Zambia [5].

Households in close proximity to breeding sites have higher mosquito densities and are at increased risk of transmission, usually following a seasonal pattern [6]. However, irrigation, roads and urbanization may create breeding sites that persist throughout the year, diminishing the seasonal effect [7]. These environmental risk factors interact with socio-cultural factors at the level of the household, including socioeconomic status, bed net use, and the type of construction of human dwellings [8]. These findings suggest that despite high perennial transmission, there may be important seasonal differences in risk factors. The weight of malaria is to a great extent credited to human mobility particularly in zones going for its elimination [9]. In this regard, setting up wellspring of infection requires knowing individual ongoing travel history [9]. In this regard, distinguishing the wellsprings of imported diseases, caused as a result of human travel outside the region and regions of high receptivity inside the district could incredibly improve malaria control programs as this would help target intercessions rightfully [10]. Additionally, a study conducted by Tesfay et al. [11] found that having low knowledge level of Malaria signs and symptoms was found to be a risk of contracting malaria. Those that had low knowledge of malaria signs and symptoms were more likely to develop malaria compared to those that had high knowledge.

During the last decade, under the previous National Malaria Strategic Plans (2005–2010 and 2011–2016), Zambia made substantial progress in scaling up proven interventions, including the use of LLINs, IRS, prevention during pregnancy with LLINs and IPTp, and improved case management at health facility and community levels with diagnostic confirmation using rapid diagnostic tests (RDTs) and/or microscopy along with ACT treatment.

In terms of transmission in Southern province, there was a steady increase in the incidence rates from 35.7/1000 in 2016 to 46.0/1000 in (2018). In Gwembe District, in particular, the incidence rate as of 2018 was at 241.7/1000 (malaria DHIS2). The 2015 Malaria Indicator Survey report [12] clearly indicates that the parasite prevalence reduction is not homogenous, with some regions having incidence as high as 806.9/1000 in North Western Province, while Southern Province had estimates as low as 26.7/1000. This is an important issue in the fight against malaria because areas of high malaria parasite prevalence are potentially the epicenter of a surge of malaria infections towards areas with lower malaria burden, whenever conditions are favorable for mosquito breeding [13]. It is therefore important to understand the reasons that contribute to high malaria transmission in some areas and not in the others.

There has been a large variation in the malaria incidence rate between Munyumbwe and Sompani Rural Health Centres (RHCs) of Gwembe district. Malaria incidence in 2019 were 6/1000 in Munyumbwe and 117/1000 in Sompani [3] despite the two HCs receiving the same type of malaria intervention annually and routinely which include the use of long lasting insecticide nets (LLINs), IRS, prevention during pregnancy with LLINs and IPTp, and improved case management at health facility and community levels. Not only this but also that the two RHCs have similar geographical and climatic conditions.

The ultimate vision is to attain a malaria free Zambia and the goal is to eliminate local malaria infection and disease by 2021, maintain malaria-free status, prevent reintroduction and importation of malaria into areas where the disease has been eliminated [14, 11]. However the variation in transmission rates pause a challenge to attain this. The study aimed at determining the factors associated with malaria transmission in Sompani as opposed to Munyumbwe RHC.

2. Methods

2.1. Study Design

This was a cross sectional study of all malaria tested clients seen at Munyumbwe and Sompani RHC between 4th January and 29th February 2020.

2.2. Study Site and Population

The study was conducted in Munyumbwe and Sompani RHCs located in Gwembe district of Southern province in Zambia. Sompani is about 12km away from Munyumbwe RHC and the two share boarders. According to the 2019 projected Central Statistics Office report, Munyumbwe and Sompani have a population of 7500 each. There are approximately 1500 households in Munyumbwe and 1550 households in Sompani. Both RHC communities are characterized by mountainous geographical formations, seasonal fast flowing streams, warm to hot weather conditions normal to below normal rain patterns. The two facilities have similar latitudes and longitudes (Munyumbwe latitude -16.641 and a longitude of 27.773 while Sompani has latitude of -16.744 and a longitude of 27.741). Communities of Munyumbwe and Sompani are predominantly subsistence farmers with no major economic activities available, with

most people having attained primary education level.

Gwembe District has 17 Health Centres and out of these, 7 are located along the lake shore of Kariba and these facilities have a similar pattern of prevalence with minimal differences. The remaining 10 Health facilities are located on the dry lands and 9 of them have a similar disease pattern in exception of Sompani RHC. Among the ten RHCs located on the dry land Sompani and Munyumbwe RHC have similar geographical and climatic conditions. They have also been implementing the same malaria prevention interventions at the same time since 2014. It was for this reason that the study sites were chosen because they have same malaria intervention package, similar geographical and climatic conditions and the only difference between them being the malaria transmission rates. However, it must be noted that the findings of this study cannot be generalized to other areas within the district or beyond because the factors been studied are unique to the study sites.

2.3. Dependent and Independent Variables

The dependent variable was malaria and independent variables were grouped as individual factors (Age, Gender, Outdoor activities, human mobility, Awareness Knowledge and Education), Health care factors (Facility/Clinic, Index case follow up, Number CHW), and Household factors (ITN possession, ITN utilization, IRS, Presence of stagnant water). Human mobility was measured by considering whether a person travelled outside the district and spent at least one night in that district (Trans in or out) in the last 30 days. Coverage of interventions on IRS and ITNs were measured whether a household had their house sprayed in the last 12 months or not and ITN was measured whether a household has at least one or more ITNs. Utilization was measured whether a person slept under an ITN the previous night. Index case followed up was measured by whether a positive case was followed up or not. A ratio of 1 CHW to 500 persons was considered adequate human resource.

2.4. Sample Size and Sampling

The study involved primary data collection. The minimum sample size for the study was 315 and we enrolled 340 with 170 participants from each facility. The study population included all tested malaria clients of all age groups seen at Munyumbwe and Sompani RHC between 4th January and 29th February 2020. Participants must have been permanent residents for at least six months and we excluded clients with severe signs and symptoms of malaria because they were not physically sound to participate in the study.

2.5. Data Collection Tool and Technique

A structured questionnaire was administered to all the participants. Questions in the questionnaire comprised of researcher generated questions and questions adopted from the 2015 Malaria Indicator Survey. The interviews were conducted immediately the patient was tested for malaria right at the facility. Written parental or guardian consent was obtained on behalf of all participants under 16 years of age as well as the child's verbal assent to participate in the study for children aged 7 years to less than 16 years. For confidentiality purposes, data was collected in a private place. The questionnaire was administered by data collection assistants who were trained prior to the activity. This study was approved by the University of Zambia Biomedical Research Ethics Committee (UNZABREC- ref: 271-2019) and National Health Research Authority (NHRA).

2.6. Data Analysis

All analysis were done using STATA version 14 SE (Stata Corporation, College Station, TX, USA). Descriptive data summarized using frequency tables. To determine the association between independent variables and the outcome, Chi square test was used on categorical variables whose expected cell frequencies were equal or greater than 5 if otherwise fisher's exact test was used as shown in table 1. Wilcoxon rank test was used to check for any differences in the continuous variable such as age, since it was skewed, the median and Interquartile Range (IQR) were reported. Logistic regression analysis was performed to test the association between binary response variables and their corresponding explanatory variables and to control for confounding, multivariable logistic regression was performed.

To identify the best predictors of factors associated with malaria transmission, Multivariable Logistic Regression using the backward stepwise selection was done beginning with variables which had $p<0.2$ in univariate analysis. The outcome measure of this study was Odds Ratio and the level of significance was set at 95% and 0.05 error. Hence the association was considered statistically significant if p value was <0.05.

Cross tabulation using Chi square was used to analyze the variable index case followed as this did not meet the criteria to be included in logistic regression because it was only applicable to the positive cases. As for number of CHWs a standard ratio of 1 CHW to 500 persons is what is considered adequate according to the 2017 Zambia Integrated Community Case Management Guidelines. This ratio was used to determine whether CHW against catchment population ratio was adequate for Munyumbwe and Sompani RHCs.

3. Results

3.1. Characteristics and Associated Factors of Malaria Transmission in Sompani and Munyumbwe RHCs in Gwembe District

Table 1 shows that 50% (85/170) of the participants from Sompani RHC had Malaria while Munyumbwe RHC had 5.9% (10/170) of the participants with malaria. The age distribution for participants who had malaria from Sompani RHC was from 11 years to 39 years with a median age of 21 years compared to participants who had malaria from

Munyumbwe RHC whose age distribution was from 7 years to 25 years with median age of 28 years. While patients who had no Malaria at Sompani health facility had their age distribution from 15 years to 43 years with median age of 24 as compared to Munyumbwe health facility who had age distribution from 16.5 years to 40 years with a median age of 26.

At Sompani RHC, out of 85 patient who had Malaria, 40 (88.89%) had travelled outside the district, this was statistically significant with p-value <0.0001 compared to Munyumbwe RHC where 10 patients who had Malaria, 1 (12.50%) had travelled outside of the district. This was not statistically significant with p-value 0.415.

Out of the 85 participants who had Malaria at Sompani RHC 4 (15.38%) used an ITN the previous night. While out of 10 participants who had Malaria at Munyumbwe RHC 9 (90%) used an ITN the previous night. This association was statistically significant only at Sompani RHC with p-value <0.0001.

However, the results show that at both Sompani and Munyumbwe RHC house spraying, ITN possession, and presence of stagnant water were not statistically significant.

It was observed that at Sompani RHC out of 85 patients who had malaria, 5 (5.88%) index cases were followed up as opposed to Munyumbwe which followed up 90% (9 out of 10) of the index cases.

The number of CHWs for Munyumbwe RHC was 15 and Sompani had 3. The population for Munyumbwe was 7500 and Sompani was 7500. As a proportion against the catchment population and compared to the standard ratio of 1:500 persons. Munyumbwe RHC had a CHW against catchment population ratio of 1:500 while Sompani had a ratio of 1:1250.

Table 1. *Characteristics and associated factors of malaria transmission in Sompani and Munyumbwe RHCs in Gwembe District.*

Factors	Sompani (n=170)			Munyumbwe (n=170)		
	Transmission		P-value	Transmission		P-value
	Yes n (%)	No n (%)		Yes n (%)	No n (%)	
Individual Factors						
Malaria	85 (50)	85 (50)	n/a	10 (5.9)	160 (94.1)	n/a
Median age (IQR)	21 (11, 39)	24 (15, 43)	0.353	28 (7, 25)	26 (16.5, 40)	0.929
Sex						
Male	38 (59.38)	26 (40.63)	0.057	5 (7.46	62 (92.54)	0.48
Female	47 (44.34)	59 (55.66)		5 (4.85)	98 (95.15)	
Education						
primary	59 (50.43)	58 (49.57)	Ref	5 (4.59)	104 (95.4)	0.675
Secondary	0 (0)	2 (100)	0.252[a]	3 (10.34)	26 (89.7)	
Tertiary	12 (50)	12 (50)	0.97	0 (0)	2 (100)	
Never gone	14 (51.85)	13 (48.15)	0.894	2 (6.67)	28 (93.33)	
Awareness						
Yes	85 (50.30)	84 (49.70)	0.316	10 (5.92)	159 (94.08)	0.802[a]
No	0 (0)	1 (100)		0 (0)	1 (100)	
Knowledge						
Yes	84 (50)	81 (49.09)	0.173[a]	10 (5.95)	158 (94.05)	0.722[a]
No	1 (20)	4 (80)		0 (0)	2 (100)	
Travel outside district						
Yes	40 (88.89)	5 (11.11)	<0.0001	1 (12.50)	7 (87.50)	0.415[a]
No	45 (36)	80 (64)		9 (5.56)	153 (94.44)	
Household Factors						
House sprayed (IRS)						
Yes	84 (50.91)	81 (49.09)	0.173[a]	9 (5.42)	157 (94.58)	0.1[a]
No	1 (20)	4 (80)		1 (25)	3 (75)	
ITN Possession						
Yes	42 (46.67)	48 (53.33)	0.753	10 (6.37)	147 (93.63)	0.348[a]
No	43 (53.75)	37 (46.25)		0 (0)	13 (100)	
ITN Utilization						
Yes	4 (15.38)	22 (84.62)	<0.0001[a]	9 (5.81)	146 (94.19)	0.892[a]
No	81 (56.25)	63 (43.75)		1 (6.67)	14 (93.33)	
Outdoor Activities						
Yes	82 (52.56)	74 (47.44)	0.072[a]	8 (5.52)	137 (94.48)	0.626[a]
No	3 (21.43)	11 (78.57)		2 (8)	23 (92)	
Presence of stagnant water within 5km						
Yes	8 (47.06)	9 (52.94)	0.798	1 (12.50)	7 (87.50)	0.415[a]
No	77 (50.33)	76 (49.67)		9 (5.56)	153 (94.44)	

Characteristics and associated factors - Health Care Factors

	Index cases followed up	Index cases not followed up	p-value
Sompani	5 (6.3)	80 (93.7)	<0.0001[a]
Munyumbwe	9 (90)	1 (10)	

***** Note that: [a] denotes Fisher's exact the rest were obtained using chi square.

Standard ratio of 1 CHW: 500 persons against the catchment population.

Munyumbwe (pop. 7500, CHW 15) 1:500, Adequate.

Sompani was (pop. 7500, CHW 6) 1:1250, Inadequate.

3.2. The Bivariate and Multivariable Logistic Regression

Table 2 below shows the stratified analysis of unadjusted and adjusted estimates for Munyumbwe and Sompani RHC. ITN utilization at Munyumbwe RHC had an unadjusted odds ratio of 0.86 and a p-value of 0.893. When adjusted for other variables in the model, ITN utilization had an odds ratio of 0.03 and a p-value of 0.042 which was statistically significant. Gender, Education, Awareness, Knowledge, traveling outside the district, having your house sprayed, late outdoor activities and presence of stagnant water were found to be statistically insignificant for both adjusted and unadjusted logistic regression model for Munyumbwe RHC.

At Sompani RHC, Age had an unadjusted odds ratio of 0.99 and a p-value of 0.477, when adjusted for other variables in the model had an odds ratio of 0.99 and a p-value of 0.983 which was statistically insignificant. Traveling outside the district had an unadjusted odds ratio of 6.22 and a p-value of <0.0001, when adjusted had an odds ratio of 13.44 and a p-value of <0.0001 which both remained statistically significant. ITN utilization had an unadjusted odds ratio of 0.2 and a p-value of 0.001, when adjusted had an odds ratio of 1.18 and a p-value 0.021 which was statistically significant.

However, gender, education, awareness, Knowledge, having your house sprayed, ITN possession, late outdoor activities and presence of stagnant water were not statistically significant for both unadjusted and adjusted logistic regression.

Table 2. *Bivariate and Multivariable estimates.*

Predictors	Munyumbwe					
	Unadjusted			Adjusted		
	OR	95% CI	p-value	OR	95% CI	p-value
Individual Factors						
Age	1.02	(1.00, 1.05)	0.167	1.02	(1.00, 1.05)	0.085
Gender	0.63	(0.18, 2.27)	0.483	0.38	(0.08, 1.88)	0.236
Male	Ref					
Female	0.63	(0.18, 2.27)	0.483	0.38	(0.08, 1.88)	0.236
education	1.14	(0.68, 1.93)	0.613	1.18	(0.61, 2.28)	0.63
Primary	Ref					
secondary	1.1	(0.58, 2.09)	0.763	3.7	(0.87, 15.79)	0.077
Tertiary	-	-	-	-	-	-
Never gone	0.89	(0.45, 1.74)	0.725	0.91	(0.16, 5.29)	0.373
Awareness about malaria						
No	Ref					
Yes	1			1		
Knowledge on malaria						
Not knowledgeable	Ref					
Knowledgeable	1			1		
Travel outside district						
No	Ref					
Yes	2.43	(0.27, 21.93)	0.429	1.53	(0.08, 9.87)	0.78
Household Factors						
House sprayed						
No	Ref					
Yes	1.17	(0.02, 1.82)	0.144	0.14	(0.01, 2.70)	0.195
ITN Possession						
No	Ref					
Yes	1			1		
ITN Utilization						
No	Ref					
Yes	0.86	(0.10, 7.31)	0.893	0.03	(0.001, 0.88)	0.042
Outdoor Activities						
No	Ref					
Yes	0.67	(0.13, 3.36)	0.628	1.55	(0.19, 12.37)	0.681
Presence of stagnant water within 5km						
No	Ref					
Yes	2.43	(0.27, 21.93)	0.429	5.77	(0.51, 65.58)	0.605

Table 2. *Continued.*

Predictors	Sompani					
	Unadjusted			Adjusted		
	OR	95% CI	p-value	OR	95% CI	p-value
Individual Factors						
Age	0.99	(0.98, 1.01)	0.477	0.96	(0.97, 1.03)	0.983
Gender	0.55	(0.29, 1.02)	0.059	0.79	(0.30, 2.09)	0.637
Male						
Female	0.55	(0.29, 1.02)	0.059	0.79	(0.30, 2.09)	0.637
education	1.01	(0.78, 1.30)	0.949	0.73	(0.43, 1.24)	0.239
Primary						
secondary	4.33	(0.44, 42.88)	0.21	12.16	(0.74, 19.49)	0.08
Tertiary	Omitted					
Never gone	16.16	(0.91, 26.99	0.132	1.42	(0.26, 2.78)	0.711
Awareness about malaria						
No						
Yes	1			1		
Knowledge on malaria						
Not knowledgeable						
Knowledgeable	4.15	(0.45, 37.91)	0.208	21.94	(1.00, 480.09)	0.05
Travel outside district						
No						
Yes	6.22	(5.24, 8.62)	<0.0001	13.44	(11.20, 13.84)	<0.0001
Household Factors						
House sprayed						
No						
Yes	4.15	(0.45, 37.91)	0.208	4.73	(0.20, 12.73)	0.337
ITN Possession						
No						
Yes	0.91	(0.49, 1.68)	0.753	1.66	(0.59, 4.64)	0.336
ITN Utilization						
No						
Yes	0.2	(0.08, 0.50)	0.001	1.18	(0.04, 0.77)	0.021
Outdoor Activities						
No						
Yes	3.24	(0.84, 12.40)	0.087	5.32	(0.68, 41.44)	0.111
Presence of stagnant water within 5km						
No						
Yes	0.88	(0.32, 2.39)	0.798	0.59	(0.12, 3.05)	0.533

3.3. The Degree of Association Between Best Predictors and Malaria Transmission

Table 2 shows the stratified analysis for best predictors of Malaria transmission at Sompani and Munyumbwe RHCs. At Sompani RHC, the predictors were; having travelled outside and ITN utilization while Munyumbwe health facility had ITN utilization as the only statistically significant predictor in the model (age, ITN utilization).

After backward stepwise regression, the study respondents who had travelled outside the district were 29.48 increased odds of acquiring Malaria compared to those who never travelled at Sompani RHC. This could be as low as 25.72 to as high as 33.42 in the actual population, this difference was statistically significant with a p-value <0.0001 adjusting for ITN utilization.

The study also revealed that respondents at Sompani RHC who utilized ITNs had 89% reduced chance of acquiring Malaria as compared to those who never utilized. This was as low as 0.02 to as high as 0.53 in the actual population, this was statistically significant with a p-value 0.006, controlling for travelling outside the district in the model. ITN utilization was equally statistically significant at Munyumbwe RHC. The participants at Munyumbwe RHC who utilized ITNs had 96% reduced chance of acquiring Malaria compared to those who never utilized adjusting for age in the model (p-value 0.04, 95% CI 0.02, 0.91).

Furthermore, the study results from the cross tabulations for index case follow up showed that there was an association between index cases followed up and malaria transmission. At Sompani RHC out of the 85 index cases only 6% were followed up while at Munyumbwe RHC out of the 10 index cases 90% were followed up and this was statistically significant at p-value <0.0001.

Lastly the study revealed that the number of CHWs for Munyumbwe RHC was 15 and Sompani had 3. The population for Munyumbwe was 7500 and Sompani was 2250. As a proportion against the catchment population and compared to the standard ratio of 1:500 persons. Munyumbwe RHC had a CHW against catchment population

ratio of 1:500 while Sompani had a ratio of 1:770.

Table 3. *The Best Predictors of malaria transmission at Sompani and Munyumbwe Rural Health Centres in Gwembe District.*

Predictors	Odds ratio	95% CI	p-value
Munyumbwe			
Age	1.02	(0.99, 1.04)	0.237
ITN Utilization	0.2	(0.02, 0.91)	0.04
Sompani			
Travelled outside district	29.48	(25.72, 33.42)	<0.0001
ITN Utilization	0.11	(0.02, 0.53)	0.006

4. Discussion

This study sought to identify and compare the factors associated with Malaria transmission in Sompani and Munyumbwe catchment areas of Gwembe district. The findings for the study revealed that traveling outside the district had a significant association with Malaria transmission at Sompani. This is supported with similar studies conducted by Aschale, Y. et al. and Killeen, G. F [15, 16] showed that human mobility and momentary travel were associated with malaria transmission. A similar research carried out by Lowa, M., et al. [17] in Lusaka were it was observed that there was a high extent of imported Malaria contrasted with cases that originated within Lusaka, which is a low malaria burden area.

Additionally, the study revealed that ITN utilization had a significant association with Malaria transmission. Such is also in line with the findings by Njumkeng, C. et al. [18] where they found that the highest prevalence of malaria was recorded among non-ITN users while regular ITN users had the least chance of acquiring malaria. Thus, fewer mosquito bites means fewer inoculations and therefore, fewer malaria infection episodes. Additionally, a malaria outbreak investigation study by Tesfay et al. [11] conducted in Tigray region of Ethiopia also found similar results. Using a Multivariate regression model the study found that irregular use of ITNs and inadequate use of ITNs increased the chances of contracting Malaria as compared to those that had regular and adequate use of ITNs respectively. However, results from the study indicated that having your house sprayed, ITN possession and presence of stagnant water had no significant association with Malaria transmission.

This study showed that there was a strong association between index case follow up and malaria transmission. There was less effective case index follow-up in Sompani catchment area as compared to Munyumbwe catchment area were more positive cases were followed-up. Not following up of additional individuals surrounding an index case, had the potential to increase the transmission rates since pockets of asymptomatic individuals were not been identified at Sompani RHC, which contributed significantly to the high transmission rates (incidence) at Sompani. The low ratio of CHW in Sompani may partially explain the low index case follow-up rate, as this is the responsible cadre for index case follow up. Furthermore, a research conducted by Sturrock, Hsiang [19] that asymptomatic malaria can be present across the malaria spectrum, and is higher in households of identified clinical cases and in the neighborhood where index cases are not followed up.

Furthermore, the showed that there was an association between number of CHWs and malaria transmission. Sompani compared to Munyumbwe had inadequate number of CHWs against the catchment population who could have improved access to early malaria diagnosis, treatment and health education and index case follow up at community level which is fundamental parts of fruitful malaria control. This is supported by the study done by Canavati, de Beyl [20], in which their examination demonstrated that CHWs' geographical proximity to their catchment network expanded the plausibility and viability of malaria treatment, especially with regards to treatment, and patient follow-up, which are all mainstays of the malaria program.

5. Conclusion

Malaria prevalence differs within different health facility catchment areas in the same district. Considering the differences in prevalence between Munyumbwe and Sompani, the following factors; Travelling outside the district had a significant association of acquiring malaria at Sompani. Additionally, only a minority of index cases are followed up in Sompani, in contrast to Munyumbwe due to inadequate number of CHWs. ITN utilization was significant at both health facilities.

6. Recommendations

Providing malaria prophylaxis to travelers, strengthening index case follow-up and training of adequate CHWs are potential strategies to control malaria in Sompani and Munyumbwe RHCs.

Limitations of the Study

Although the study was able to identify individual, household and health care factors and predicted the degree of association with Malaria transmission at both health facilities. There is need to conduct another study using a longitudinal study design or a mixed method that is (both qualitative and quantitative method) that will also be able to identify entomological, social and cultural factors that may be associated with Malaria transmission. Furthermore, conducting another study on factors associated with malaria transmission in other high burden districts to determine consistency of results.

Author Contributions

MM, LS, NS, BH and PM have conceived, designed the study and involved in the data analysis, interpretation and critical revision of the manuscript. MM collected the data. The write up and final manuscript was done by all the authors.

Competing Interest

The authors have declared that no competing interests exist.

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