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Research Article

Investigation of Malaria Outbreak in Sagambe Area, Mutasa District, Zimbabwe

Maxwell Moyoweshumba[1], Maxwell Mhlanga[2,*]

[1]Faculty of Health Sciences, Africa University, Mutare, Zimbabwe
[2]Centre of Gender Equity, University of Global Health, Kigali, Rwanda

Abstract

The burden of Malaria remains a global concern, killing millions of people annually, yet it is a preventable and curable disease.. Malaria, a mosquito-borne disease caused by a parasite, leads to fever, chills, and flu-like symptoms, and can be fatal if untreated. In Zimbabwe, the malaria incidence rate decreased from 39 cases per 1,000 people in 2014 to 25 per 1,000 in 2015, a 36% reduction. A study in Sagambe, Mutasa District aimed to identify risk factors for contracting malaria. Using a 1:1 unmatched case-control study, 88 cases and 88 controls were examined. Data were collected via interviewer-administered questionnaires for cases and controls, and self-administered questionnaires for key informants. Evening outdoor activity significantly increased the risk of malaria (AOR = 9.71, 95% CI 1.97-47.85). Other risk factors included sex (p = 0.023), not owning a mosquito net (OR = 0.26, 95% CI 0.14-0.49), not sleeping under a net the previous night (OR = 0.14, 95% CI 0.07-0.35), not closing windows after sunset (OR = 4.39, 95% CI 1.79-11.11), and not wearing long sleeves outdoors (OR = 0.08, 95% CI 0.01-0.56). The outbreak was linked to evening outdoor activities. Participants had high knowledge of malaria transmission but limited awareness of symptoms beyond headache and general body weakness. The study suggests enhancing health education campaigns in Sagambe.

Keywords

Malaria Outbreak Investigation, Sagambe Area Mutasa District, Manicaland Province, A 1:1 Unmatched Case Control Study

1. Introduction

Malaria is a mosquito-borne disease caused by the Plasmodium parasite, resulting in fever, chills, and flu-like symptoms. Without treatment, malaria can lead to severe complications and death [1]. The disease is prevalent in tropical regions, with the highest rates in sub-Saharan Africa, India, and Southeast Asia [2]. In 2017, there were an estimated 219 million malaria cases globally, with 92% in the WHO African Region, followed by the WHO South-East Asia Region at 5% [3]. Malaria caused approximately 435,000 deaths worldwide in 2017, with 93% of these deaths occurring in the WHO African Region [3].

In 2015, the WHO estimated 214 million malaria cases globally, with the African Region accounting for 88%, the South-East Asia Region 10%, and the Eastern Mediterranean Region 2% [2]. Zimbabwe faces a significant malaria burden, with about 80% of residents at risk (USAID, 2016). Children under five, pregnant women, and people living with HIV/AIDS are particularly vulnerable [1]. Plasmodium falciparum is responsible for 98% of malaria cases in Zimbabwe, with Anopheles arabiensis being the primary vector [4].

*Corresponding author: Profmaxmhlanga7@gmail.com (Maxwell Mhlanga)

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Zimbabwe has made progress in reducing malaria cases and deaths. In 2015, the Ministry of Health and Child Care (MOHCC) recorded 300,890 malaria cases and 412 deaths, a significant decrease from 535,933 cases and 578 deaths in 2014, indicating a 36% reduction in incidence [5]. In 2015, 83% of malaria cases and 61% of deaths were concentrated in Manicaland, Mashonaland East, and Mashonaland Central provinces, with Manicaland having the highest burden [6]. The epidemiology of malaria transmission in Zimbabwe varies with elevation and rainfall patterns, with transmission peaking between November and April [4, 6].

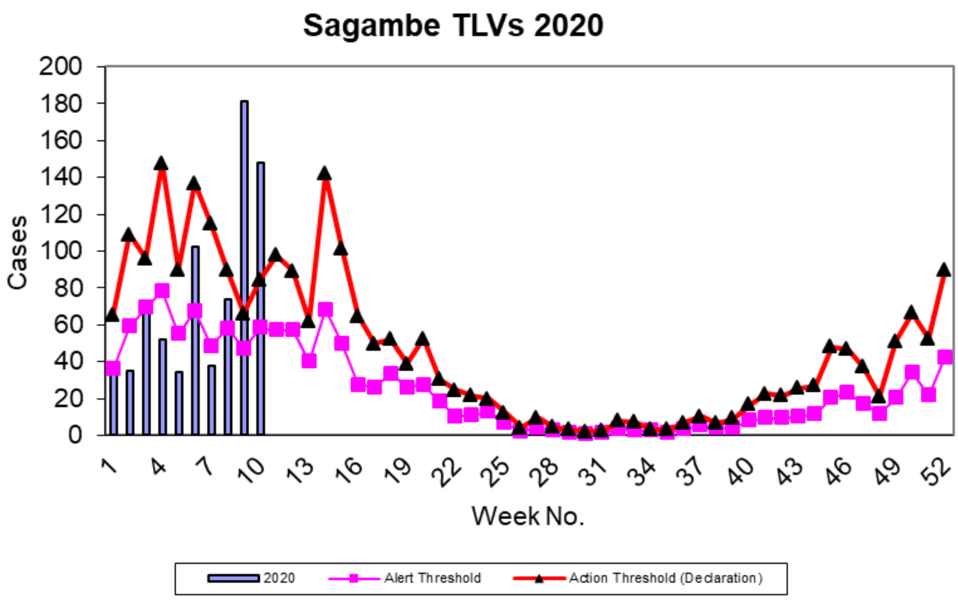
Malaria control in Zimbabwe involves case management, insecticide-treated nets (ITNs), and indoor residual spraying (IRS). These measures have significantly reduced malaria transmission in many parts of the country [1, 7]. However, challenges remain, particularly in Manicaland Province, which continues to experience high malaria rate [1]. Increasing the use of IRS and long-lasting insecticide-treated nets (LLINs) is crucial for achieving universal coverage and reducing malaria transmission [8].

Zimbabwe's malaria control strategies are tailored to district-specific malaria burdens and include vector control measures such as IRS, LLIN distribution, larvicides, and personal protection. These measures are implemented in 44 districts with high to moderate malaria burdens. Additionally, intermittent preventive treatment in pregnancy (IPTp) is targeted in 27 districts [9].

Mutasa District, the study site, covers 2,774 square kilometers and borders Mutare, Nyanga, Makoni, and Mozambique. The district features diverse ecological regions and has a rugged terrain, with temperatures ranging from 19-26 ℃ and altitudes between 600-1500 meters. Rainfall varies from 650-1000 millimeters. Economically, Mutasa District relies on subsistence and commercial farming, as well as mining in its southern part.

The population of Mutasa District in 2020 was 178,823, with 47.1% males and 52.9% females. The district has a young population, with 39% aged 1-15 years and 27.1% aged 5-14 years. Women of childbearing age (WOCBA) constitute 44.8% of the population, with 5% expected pregnancies and 4% expected births. Adolescents (10-19 years) make up 12.17% of the population, highlighting the need for targeted health interventions for these age groups.

Sagambe TLV 2020 (week 1-10)



(Source weekly RDNS, Week 9 and 10)

Figure 1. *Sagambe TLV.*

Week 9 and 10 of 2020, Sagambe clinic recorded cases that exceeded the action Threshold Limit Value (TLV) about first time in about seven years. Unlike the host of the other facilities that had recorded episodes of outbreaks, Sagambe clinic had remained for years without recording any case of any outbreak. Thus the researcher would need to establish factors implicated for the outbreak in the two weeks (9&10) thus advice for the institution of preventive intervention. This study sought to determine risk factors associated with contracting malaria in Sagambe area, Mutasa District in 2020. Specific objectives were:

1. To describe the malaria outbreak by person, place and time in Sagambe area.
2. To assess community knowledge and practices regarding malaria prevention in Sagambe area.
3. To determine risk factors associated with contracting malaria in Sagambe area.
4. To carry out environmental assessment in Sagambe area.

5. To describe the epidemic preparedness and response to the malaria outbreak in Sagambe area in district.

2. Methods

2.1. Study Design

A 1: 1 unmatched case control study design was used for the malaria outbreak investigation. Unmatched case control study design bear efficient Sampling when the Total Number of Cases and Controls Is fixed.

Study setting

The study was carried out in Sagambe community in Mutasa district.

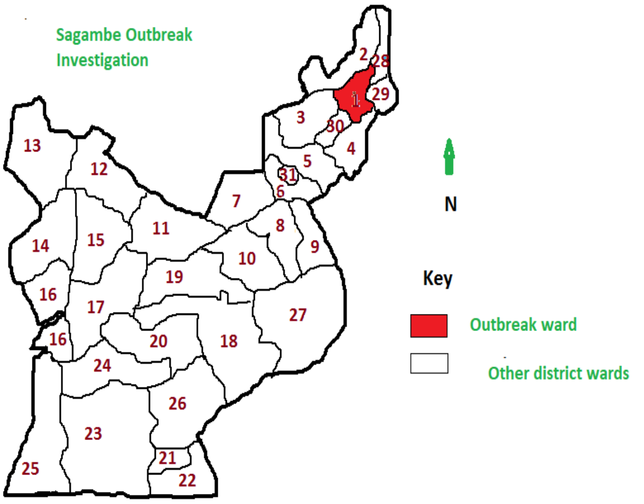


Figure 2. *Sagambe Map.*

2.2. Study Population

The study population was made up of people who lived in Sagambe community in Mutasa District.

A Case: Any person who was a resident of Sagambe community and presented himself/herself to Sagambe clinic or to village health workers within the outbreak period and would have been diagnosed malaria positive by rapid diagnostic test (RDT) or microscopy.

A Control: Any person who resided in Sagambe community and lived in the same household/homestead or neighbourhood with the cases and tested RDT or microscopy negative within the malaria outbreak period.

2.3. Inclusion Criteria

All the residents of Sagambe who had attained at least majority age of 18 years and were staying in the area from January 2020 to March 2020 who were diagnosed of malaria in week 9 and 10 of 2020.

2.4. Exclusion Criteria

All people who did not reside in Sagambe community or come to Sagambe after the study time of January to March 2020.

2.5. Sample Size

Using a 1:1 unmatched cases control study, sample size was calculated using Sample size calculator at confidence level of 95%, population size 339, margin of error 9%. Assuming outdoor evening activities to be a significant risk factor for contracting malaria with an Odds Ratio of 4.43 and 78.6% of the controls exposed from a study done by Mundagowa and others [10]. A sample size of 176 (88 cases and 88 controls) was selected for the study.

2.6. Sampling

Cases were enrolled using systematic random sampling from the line listing. The sampling interval of 2 was obtained by dividing the required sample size by the total number of cases from weeks 9 and 10. A number between 1 and 10 was randomly selected by drawing from a hat. The selected number marked the first case in the line list, with subsequent cases selected by adding the sampling interval.

Controls were identified from the same villages as the cases. An equal number of controls were chosen using simple random sampling, selecting one unaffected family member or a malaria-negative individual from the next household.

2.7. Data Collection Tools

An interviewer-administered questionnaire collected data on demographics, malaria knowledge, risk factors, indoor residual spraying, and health-seeking behaviors. A checklist assessed case management and the environment. Line lists selected cases. Data collection tools were pretested in Sagambe on 10% of the sample to ensure sensitivity, excluding these participants from the main study.

2.8. Data Analysis

Data was analysed using Epi Info version 7. Odds ratios at 95% confidence level was calculated and used to test for strength of association and significance of the factors.

2.9. Ethical Considerations

Permission to carry out the study was sought from the Provincial Medical Directorate. Written consent was sought from all participants, privacy and confidentiality were maintained throughout the study.

3. Results

3.1. Description of the Outbreak

A total of 181 were confirmed malaria cases from within Sagambe catchment area from week 9 with an incidence rate of 37/1000 population. The cases were mainly coming from Chavhanga, Mapureti, Mubata, Marume and Maya villages.

3.2. Socio Demographic Characteristics

The number of participants who were enrolled into the study comprised of 87 cases and 87 controls. Table 1 below shows the socio demographic characteristics of the study participants for both cases and controls.

Table 1. Socio demographic characteristics.

Variable (%)	Cases (N=87) n (%)	Control (N=87) n (%)	OR (95%) (CI)	P value
Age (years)				
11-20	32 (36.78)	16 (18.39)	4.00 (0.34-47.50)	0.282
21-30	12 (13.79)	17 (19.54)	1.41 (0.11-17.40)	1.000
31-60	21 (24.14) 74%	36 (41.38) 79%	1.41 (0.11-17.40)	1.000
Sex				
Female	33 (37.93)	48 (55.17)	0.49 (0.27-0.91)	0.023
Male	54 (62.07) 87	39 (44.83) 87		
Marital status				
Single	33 (33.33)	23 (26.44)	Ref	
Married	44 (50.57)	51 (58.62)	0.60 (0.31-1.17)	0.273
Divorced	2 (2.31)	4 (4,60)	0.35 (0.06-2.06)	0.402
Widowed	8 (13.79)	9 (10.34)	0.93 (0.34-2.56)	1.000
Level of education				
None	0 (0.00)	3 (3.45)		
Primary	46 (52.81)	27 (31.03)	0.084	
Secondary	40 (45.98)	54 (62.07)	0.968	
Tertiary	1 (1.15)	3 (3.45)	1.000	
Religion				
None	17 (19.54)	24 (27.59)	Ref	
Apostolic Church	47 (54.02)	34 (39.08)	1.95 (1.91-4.18)	0.084
Pentecostal church	16 (18.39)	23 (26.43)	0.98 (0.40-2.39)	0.968
Other	7 (8.05)	6 (6.90)	1.65 (0.47-5.78)	0.434
Livelihood				
Farming	83 (95.40)	86 (98.85)		
Other	4 (4.60)	1 (1.15)	4.14 (0.45-37.86)	0.368

3.3. Knowledge About Malaria

The study showed high awareness among both cases and controls about malaria transmission by mosquitoes (89.66%). Most recognized malaria's prevalence during the rainy season and were knowledgeable about fever, headache, and weakness as symptoms. Preventive measures like sleeping under mosquito nets were well known, but knowledge of using repellents varied.

Table 2. *Knowledge on malaria.*

Factor	Cases n (%) (N=87)	Controls n (%) (N=87)	P-value
Malaria transmitted by mosquito			
Yes	78 (89.66)	78 (89.66)	1.000
No	9 (10.34)	9 (10.34)	
Season			
Malaria season	85 (97.70)	84 (96.55)	
Rainy season	2 (2.30)	3 (3.45)	
Winter	-	-	
Signs and symptoms			
Fever	33 (37.93)	38 (43.68)	0.351
Headache	61 (70.11)	69 (79.31)	0.163
Sweating	14 (16.09)	19 (21.84)	0.334
Weakness	75 (86.21)	61 (70.11)	0.010*
Nausea and vomiting	41 (24.14)	49 (56.32)	0.225
Muscle and joint pains	21 (24.14)	21 (24.14)	1.000
Other	9 (10.34)	7 (8.05)	
Mosquito breeding			
Stagnant water	80 (91.95)	81 (93.10)	0.773
Running water	2 (2.30)	1 (1.15)	1.000
Other	23 (26.44)	32 (36.78)	
Malaria preventable			
Yes	85 (97.70)	83 (95.40)	0.117
No	2 (2.30)	4 (4.60)	
Malaria Prevention strategies			
Sleeping under mosquito net	81 (93.10)	79 (90.80)	0.577
Using mosquito repellent	29 (33.33)	41 (47.13)	0.577
Allowing IRS	42 (48.28)	39 (44.83)	0.648
Burning mosquito coil	12 (13.79)	18 (20.69)	0.229
Closing windows after sunset	9 (10.34)	10 (11.49)	0.808
Other	24 (27.59)	32 (36.78)	

3.4. Community Practices

Study participants also indicated hospital and village health workers as their sources of treatment (p = 0.117). Strategies for control of breeding places highlighted are cutting long grass around homes (p = 1.000), filling in pot holes, poodles, ditches and galleys (p = 0.042) and allowing spray men to carry out indoor residual spraying (p = 0.363), among others.

Table 3. Community practices.

Factor	Cases n (%) (N=88)	Controls n (%) (N=88)	P value
Treatment sources			
Hospital	81 (93.10)	86 (98.85)	0.117
VHWs	86 (98.85)	79 (90.80)	0.117
Control of breeding places			
Cut long grass around home	46 (52.87)	46 (52.87	1.000
Fill I potholes, poodles, ditches, gulley	57 (65.52)	69 (79.31)	0.042*
Allow spray men to carry out spraying	42 (48.48)	48 (55.17)	0.363
Other	6 (6.90)	4 (4.60)	

3.5. Bivariate Analysis of Risk Factors Associated with Contracting Malaria

Bivariate analysis showed significant factors associated with malaria. Evening outdoor activities were highly associated with malaria (OR 5.89, p=0.0002). Wearing long clothes outdoors was protective (OR 0.08, p=0.003). Closing windows after sunset increased risk (OR 4.39, p=0.0009). Owning a mosquito net (OR 0.26, p=0.0002) and sleeping under it (OR 0.14, p=0.0002) were significantly protective. House type, conventional windows, house spraying, proximity to stagnant water, and repellent use showed no significant associations. The data suggest that behavioral and preventive measures play a crucial role in malaria risk reduction.

Table 4. Bivariate analysis of factors associated with contracting malaria.

Factor	Cases n (%) (N=87)	Controls n (%) (N=87)	OR (95%CI)	P value
Evening outdoor activities				
Yes	82 (94.25)	64 (73.56)	5.89 (2.13-16,67)	0.0002*
No	5 (5.75)	23 (26.44)		
Put on long clothes when outdoor				
Yes	1 (1.22)	9 (14.06)	0.08 (0.01-0.56)	0.003*
No	81 (98.78)	55 (85.94)		
Type of house				
Brick under thatch	19 (21.83)	11 (12.64)		
Brick under asbestos	60 (68.97)	70 (80.46)	0.50 (0.22-1.13)	0.090
Pole and dagger	8 (9.20)	6 (6.90)	0.77 (0.21-2.81)	0.694
House has Conventional windows				
Yes	45 (70.11)	52 (71.26)	0.72 (0.45-1.93)	0.870
No	42 (29.89)	35 (28.74)		
Closing windows				
After sunset	23 (51.11)	10 (19.23)	4.39 (1,79-11.11)	0.0009*
Before sunset	22 (48.89)	52 (80.77)		
House sprayed				

Factor	Cases n (%) (N=87)	Controls n (%) (N=87)	OR (95%CI)	P value
Yes	59 (67.82)	59 (67.82)	1.00 (0.53-1.90)	1.000
No	28 (32.18)	28 (32.18)		
Live near stagnant water				
Yes	68 (78.16)	65 (74.71)	1.21 (0.63-2.67)	0.487
No	19 (21.84)	22 (25.29)		
Own mosquito net				
Yes	28 (32.18)	56 (64.37)	0.26 (0.14-0.49)	0.0002*
No	59 (67.82)	31 (35.63)		
Sleep under mosquito last night				
Yes	11 (32.18)	39 (64.37)	0.14 (0.07-0.35)	0.0002*
No	76 (87.36)	48 (55.17)		
Use repellents				
Yes	3 (3.45)	5 (5.75)	0.59 (0.14-2.53)	0.72
No	84 (96.55)	82 (94.25)		

3.6. Multivariate Logistic Regression Analysis

All the factors that were significantly associated with contracting malaria ($p < 0.05$) in the bivariate analysis were assessed for independent association using multivariate logistic regression.

Table 5. *Multivariate logistic regression analysis.*

Factor	Crude OR (95% CI)	Adjusted OR (95% CI)	P value
Evening outdoor activity	5.89 (2.13-16.67)	9.71 (1.97-47.85)	0.01

Evening outdoor activity was found to be the only factor significantly associated with contracting malaria in Sagambe area after multivariate logistic regression. People who practised evening outdoor activities were 9.71 times more at risk of contracting malaria compared to people who stayed in door during the evening. The evening outdoor activities included work done outside like gold panning and farming during the evening, staying outside during hot temperatures and children playing outside.

3.7. Environmental Assessment

Environmental assessment was done for all cases and controls to check for the presence of long grass, old tyres, empty tins, stagnant water bodies and other possible conducive environments for breeding or harbouring mosquitoes, close to homesteads. The assessment showed that 69% of the study participants (both cases and controls) had long grass around their homesteads. Sixty six percent (66%) of the study participants were also close to stagnant water bodies that were within a radius of 3 km, while 28% had empty tins and 2 % had old tyres at the homestead.

3.8. Signs and Symptoms of Cases

Generally most of the cases presented with general body weakness (90%), followed by headache (76%), while the lowest proportion presented with sweating (10%). Chills and fever affected 38% of the cases while 29%, 34% and 13% had nausea and vomiting, muscle and joint pains and diarrhoea respectively.

3.9. Treatment Taken Before Going to Health Facility/Village Health Worker

Treatment taken by malaria cases before going to the hospital or village health workers showed that a greater proportion (83%) had taken no medication or any other form of treatment as depicted by the graph. Nine percent (9%) of the cases reported that they took some pain killers while six percent (6%) had used anointed water from churches and two percent (2%) took some traditional remedies. Three cases who took pain killers before going to the hospital got them from relatives while the other six bought from local shops.

3.10. Malaria Treatment and Epidemic Response

A check on the completion of the treatment course indicated that ninety seven percent (97%) of the study participants treated for malaria managed to complete their treatment course while three percent (3%) did not complete their treatment. All the cases included in the study were given Coartemether as a first line treatment drug for malaria. Ninety nine percent (99%) of the cases managed recovered from the bout of malaria after taking medication while 1% had not recovered.

The Sagambe clinic had no malaria surveillance graphs. The clinic could not even track their Village health workers weekly submitted malaria statistics. The clinic did not have updated malaria register for 2020. Data from the village health workers is relayed to Sagambe clinic mostly by phone. Sometimes village health workers board public transport to submit data and also collect malaria drugs. The challenge is for some village health workers who come from areas with poor network and transport connection like Mubata village. The ward achieved 48% and 62% room and population coverage in indoor residual spraying respectively.

4. Discussion

The age group most affected by malaria was 11-20 years, accounting for 36.78% of total cases. This aligns with a similar study in India which also found that the 11-20 year age group was the most affected [11]. However, a similar study by Franck Berger and others revealed that, the malaria risk was three times higher for people aged 40-49 years (P = 0.01) [12]. This study indicated that females were 50% less likely to contract malaria compared to males. The Roll Back Malaria Partnership of 2006 suggests this gender difference may be due to men's increased exposure to malaria vectors through occupations such as gold mining, forest logging, and night work [13]. Contrarily, a survey by Jenkins et al. in Kenya's Kisumu County found that women were 50% more likely to have malaria than men [14].

Most participants (89.7%) knew that malaria is transmitted through mosquito bites, although this was not significantly associated with having malaria (p = 1.000). Similarly, Musoke and others in 2015 found that 89.6% of participants were aware of malaria being transmitted by mosquito bites [15]. A study in Ethiopia also reported that 87% of respondents associated malaria with mosquito bites [16]. Regarding malaria season, 97.7% of cases and 96.6% of controls knew it was most prevalent during the rainy season. Headaches and general body weakness were the most frequently mentioned symptoms.

Sleeping under a mosquito net was the most common prevention strategy, reported by 93.1% of cases and 90.8% of controls, though not statistically significant (p = 0.577). This high knowledge contrasts with a study by Iriemenam and others in Nigeria, where only 14.6% knew the benefits of mosquito nets [17]. The Ethiopian study found that 93.5% were aware of the benefits of mosquito nets [16]. Both cases and controls mentioned seeking treatment from hospitals/clinics and village health workers. Other prevention strategies included cutting long grass around homes (p = 1.000), filling potholes, puddles, ditches, and gullies (p = 0.042), and allowing indoor residual spraying (p = 0.363). Evening outdoor activity was a significant risk factor for contracting malaria, similar to Namango's findings, which showed that resting outdoors was significantly associated with malaria prevalence (p = 0.011) [18].

Wearing long-sleeved clothes during evening outdoor activities reduced the risk of contracting malaria by 92%, consistent with Mugwagwa and others findings in Zimbabwe, who found that wearing protective clothing outdoors before dawn or after dusk was a protective factor (OR = 0.121, p < 0.001) [19]. Conventional windows were not significantly associated with contracting malaria (p = 0.870). However, closing windows after sunset increased the chance of contracting malaria by 4.39 times compared to closing them before sunset. According to the Ministry of Health and Child Care Manicaland in 2017, closing windows before sunset prevents mosquitoes from entering homes as they typically bite at night.

Indoor residual spraying (IRS) is a primary vector control intervention [20]. In this study, household spraying was not associated with malaria risk (p = 1.000), possibly because some cases contracted malaria before spraying began in Sagambe in December, with the outbreak recorded in mid-February 2020. Other studies have shown significant associations between IRS and reduced malaria risk. Roberts and Matthews in Uganda found that households sprayed within the last six months had a significantly reduced malaria risk, with odds 7.649 times higher for unsprayed households (95% CI 3.545–16.501) [21]. Franck Berger et al. in 2012 also found that the malaria risk was nearly tripled for people living in unsprayed houses within six months before a malaria attack [12].

Living near stagnant water bodies was not significantly associated with malaria infection (p= 0.487). This contrasts with Romedan and others in Ethiopia, which found people residing 500-1500 meters from stagnant water were 3.32 times more likely to be malaria positive than those living more than 3000 meters away (AOR: 3.32, 95% CI: 1.13, 9.76) [22]. However, this finding is similar in Malawi, where proximity to a swamp, river, standing water, or garden did not significantly relate to malaria risk [23].

Owning a mosquito net significantly reduced malaria risk by 74% compared to those without nets ($p = 0.00009$). This is consistent with Hui Liu et al. in China, who found that lack of bed nets (OR 3.21, $P < 0.05$) was associated with malaria infection [24]. Vundule et al. also found that using insecticide-treated nets significantly reduced malaria prevalence and parasite density. However, Roberts and Matthews in Uganda reported that bed net use, whether treated or not, was not significantly associated with malaria status [21]. Sleeping under a mosquito net the night before the interview protected against malaria, with participants being 86% less likely to have malaria ($p = 0.000002$). This contrasts findings in Tanzania, where sleeping under a mosquito net the previous night had an insignificant protective effect (OR = 0.44, $p = 0.12$).

Using mosquito repellents was found to reduce malaria risk by 41%, though not statistically significant ($p = 0.72$). Mugwagwa et al. (2014) found a significant protective effect, with an 8.3 times higher risk of malaria infection for those not using repellents (OR = 8.3, 95% CI 3.8-18.0).

Environmental assessment showed that 69% of participants had long grass around their homes, and 66% lived near stagnant water bodies, which provide breeding places for mosquitoes.

5. Conclusion

The study found children under 5 years were less at risk of malaria than other age groups, with men being more at risk than women. Most participants were aware that malaria is transmitted through mosquito bites, though knowledge of symptoms was low beyond headache and general body weakness. Evening outdoor activities and not using mosquito nets were significant risk factors. Stagnant water proximity and repellent use showed insignificant effects. House spraying had no effect, likely due to late implementation. There is a need for improved health education, timely data reporting, and Integrated Disease Surveillance and Response (IDSR) training for healthcare workers.

Abbreviations

IDRS	Integrated Disease Surveillance and Response
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Net
LLIN	Long Lasting Insecticidal Nets
TLV	Threshold Limit Value
WOCBA	Women of Child Bearing Age

Author Contributions

Maxwell Moyoweshumba: Writing – original draft

Maxwell Mhlanga: Data analysis and review of manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Research Fields

Maxwell Moyoweshumba: Public Health, Environmental Health, Community Health, Reproductive Health

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