International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583

The Trends and Areas of Origins of Malaria Cases in Under-Five Children

Ethel Mungaba[1], Phebby Kasimba[2]

[1]Department of Public Health, University of Lusaka, Lusaka, Zambia

[2]Faculty of Pre-med, Lusaka Apex Medical University, Lusaka, Zambia

Abstract: ***Globally, many countries have used several interventions to eliminate Malaria. This include; intermittent preventive treatment in pregnancy and insecticide-treated nets (ITNs) and indoor residual spraying (IRS). These interventions have seen a decline of malaria cases in under-five children over the past years. Despite these significant strides made over the past decade, malaria continues to be a major burden causing mortality and morbidity especially in more prone areas, under-five children and pregnant women. A quantitative and a retrospective record review was used to analyze the trends and origins of malaria prevalence in under-five children from 2015 – 2017 at Chipili Rural Health center in Chipili district of Zambia and the main focus was on confirmed malaria cases. The prevalence of laboratory confirmed malaria cases from 2015 – 2017 was found to be 3.3 cases per 1000 under-five children, 4.0 cases per 1000 under-five children and finally 4.5 cases per 1000 under-five children respectively. Females were the most affected by malaria in the first 2 years. Cases for males only exceeded that of females in the year 2017. All the cases for both sex categories were increasing starting from year 2015 to year 2017 with an exception for the female category as the number of cases remained the same from 2016 – 2017. Research is needed to investigate why under-five children and pregnant women are more vulnerable to malaria especially in rural areas.***

Keywords: Malaria, interventions, trends, mosquito, prevalence

1. Introduction

Malaria is an infection that comes about when there has been a contamination infection with protozoan parasites of the *Plasmodium* species. These species include; *Plasmodium Vivax, Plasmodium, ovale, plasmodium malariae* infections which are less common and geographically restricted and plasmodium falciparum which is very common in Africa [1, 2]. Anopheles mosquitoes propagate protozoan parasites, with *An. Funestus, An. gambiae sensu stricto,* and *An. Arabiensis* being the most common in the Africa Region [3]. Patients infected with the protozoan parasites usually show symptoms which are nonspecific and these include; chills, rigors and fever and the majority do not even require hospital admission. Serious malaria develops only in a few individuals, while in children it may manifest as severe Anaemia, fever, impaired consciousness, respiratory distress, hypoglycemia, convulsions, and among other symptoms [4]. In sub-Saharan Africa malaria is responsible for nearly 200 million clinical cases[5]. In line with the World Health Organization [6] over 300,000 malaria-related deaths annually, predominantly in children under 5 years of age. In Zambia Malaria is a major cause of mortality and morbidity, more especially in more prone areas and under-five children and pregnant women are highly vulnerable [7]. The National Health Information System (HMIS) [8] through routinely collected data reported 5.8 million cases of malaria in 2014. In a study by [9] it was found that nationally malaria incidence was at 386 per thousand persons in 2013, 409 per thousand people in 2014, and 335 per thousand in 2015. This shows a reduction in the national malaria incidence. With regards to under-five children malaria incidence was higher (756 per thousand) among these compared to others of older age groups (275 per thousand). Reduction of incidence of malaria is a National priority that demands a dedicated, all-embracing, and consistent approach in order to achieve the vision of "a malaria-free Zambia by 2030", as outlined in strategic plan of 2011-2016 of Zambia National Malaria control program (NMCP) [7]. In the last 10 years Zambia has been implementing various malaria control programs that have shown different effects depending on the resources that were available at that time [10]. And also during the 20years before 1990 there was much emphasis on Malaria control in Zambia which was centered on treatment but place little effort on prevention. Analyzing changes in trends and epidemiology of any kind of infection or disease need to be the preliminary point to help in prioritization of interventions [11]. As a way of addressing the malaria scourge, several prevention interventions have been implemented and supported and they include intermittent preventive treatment in pregnancy, indoor residual spraying (IRS) and use of insecticide treated nets (ITNS). These interventions together have had a significant effect on the decline in cases of malaria, more especially in 2000 -2008 [12]. The impact mentioned above has been identified and can be attributed to a difference in malaria epidemiology, which gives an accurate understanding of the trends of malaria to guide interventions. In fact, not paying attention to these principles might have imminent negative social and economic effects [13]. In view of the aforementioned the authors thus sought it wise to analyze the trends and areas of origin of malaria in Chipili catchment area which is in a province with the highest malaria incidence in pregnancy [9].

To eliminate malaria in Zambia several interventions have been implemented and scaled up. They include; intermittent preventive treatment in pregnancy and insecticide-treated nets (ITNs and indoor residual spraying (IRS). These interventions together have had a serious effect on the decline of malaria cases especially from 2000 -2008 [14]. Despite these significant strides made over the past decade,

malaria continues to be a major burden in Zambia, resulting in 2,000 deaths in 2016 [15].

Given the burden of malaria, there is a likely going to be adverse consequences such as anemia and other associated complications. [16] indicates that malaria is one of the factors that contribute to anemia in under-5 children. The fact that children below the age of five have not developed sufficient naturally acquired immunity to the parasite makes the suffer more from the severe effects of malaria. Children suffer an acute attack of cerebral malaria that quickly leads to coma and death; others succumb to the severe anemia that follows repeated infections, or to the consequences of low birth weight caused by malaria infection in the mother's womb. Malaria also prevents the growth of those who survive despite escaping death their cognitive development may be affected due to severe or repeated malaria infections [17].

Therefore, there was need to review the trends of malaria cases past years and to find out the factors that can account for the observed trends and origin of malaria cases in Chipili catchment. This information is important in ascertaining the effects of the existing malaria interventions in this area on the overall malaria prevalence in the area.

Significance of the Study

The study aimed at analyzing the trends and areas of origin of malaria cases in under-five children at Chipili Rural Health Centre. Despite many interventions put across by the Ministry of Health through Chipili District Health Office such as distribution of Insecticide treated nets (ITNS) to pregnant mothers and children, and also environmental awareness about external factors that may increase the risk of one contracting malaria. There had been an increase in the prevalence of malaria in under-five children in many parts of the country and the most affected province is Luapula. The findings from this study can help Chipili district health office to identify the gaps in malaria prevention programs, it can also help in allocation of resources needed in the prevention of malaria in under-five so as to reduce malaria burden. The results from this research also have the potential to help the district management to track under-five-malaria cases up-to household level by looking at the villages that recorded the highest malaria cases and this can help in knowing the actual cause of the problem as this has given the actual picture of the type of houses where these children live in. Hence the research was important in that it gave a true picture of what has been happening during the period under study (2015 – 2017) and this will help in prioritizing interventions to put across and to come up with measures of reducing under-five malaria cases within Chipili district.

There is little research of this kind that has been done in the district, therefore the research has added to the body of knowledge and has the potential to attract different stakeholders who would be interested in further investigating under-five malaria cases on a large scale and probably come up with measures that will reduce this burden.

The scope of this study was to review the trends and origin of malaria cases at Chipili Rural health Centre. The study concentrated only on under-five children who had malaria during the period under study (2015 – 2017) that had been recorded in the Outpatient Department (OPD) registers. The study narrowed its review to malaria cases which were recorded yearly than monthly.

2. Literature Review

The World Health Organization highlights that there were large reductions in the number of malaria cases and deaths between 2000 and 2015. In 2000, it was estimated that there were 262 million cases of malaria globally (range: 205–316 million), leading to 839 000 deaths (range: 653 000–1.1 million). By 2015 there was an estimated decrease in the number of malaria cases of 214 million (range: 149–303 million, and the estimated number of deaths were 438 000 (range: 236 000–635 000).

These figures equate to an 18% decline in estimated malaria cases and a 48% decline in the number of deaths during this period [18]. The World malaria report of 2014 estimated that 3.2 billion people in 97 countries and territories are at risk of being infected with Malaria and developing the disease and out of the 3.2 billion, 1.2 billion are at risk. The report shows that in 2015 212 million cases occurred globally [19].

A retrospective observation study that was done in Zambia by [20] showed that there has been a decrease in both morbidity and mortality of malaria in under-five children from 2009-2013. Results showed that in 2009 the morbidity in children in Lusaka province was 164 per 1000 population and it increases to 210 per 1000 population, in 2010 before showing gradual decrease to 78 per 1000 population in 2013. Findings from this study shows that despite the decrease in malaria trends in under five malaria burden is still high in children under five years, these results are similar with a study done by [21] in Papua New Guinea which showed that malaria morbidity was found to be highest among under-five children.

Most malaria cases in 2015 were estimated to occur in the WHO African Region (88%), followed by the WHO South-East Asia Region (10%) and the WHO Eastern Mediterranean Region (2%). Most deaths (90%) in 2015 were in the African Region of WHO followed by the South-East Region (7%) then the Easter Mediterranean Region of WHO (2%) (World Health Organization [6]. Malaria in under-five children is influenced by a number of factors or determinants which include climatic factors such as temperature, rainfall, humidity and sociodemographic factors such as age, sex, type of housing and uptake of preventive interventions like insecticide treated mosquito nets (ITNs), indoor residual spraying etc. Mostly malaria cases occur in areas which record high temperatures and rains heavily.

The literature reviewed shows that malaria is still a major public health concern especially in children under five who are highly vulnerable to this disease. Despite the slight decrease in the prevalence of malaria in many parts of the World there is need to put in more efforts to eradicate this deadly disease. This is in agreement with findings from studies which were done by [20] and [21].

3. Methodology

The study was quantitative and a retrospective record review that was used to analyze the trends of malaria from 2015-2017 and the main focus was on confirmed malaria cases. Cross sectional study design based on secondary data from confirmed under five malaria hospital records was used to determine the prevalence and malaria trend in children under the age of five at the Health center. The sample size of 384 was used in this study. Stratified sampling was used to analyze all the malaria cases reported from 2015 – 2017. Malaria cases reported from 2015 – 2017 were reviewed from laboratory record books and also information was obtained from inpatient registers on number of patients who visited the clinic for suspected malaria cases and where the patients came from. Additional information was also being gathered on diagnosis, residential area, age, gender, number of children who attended under- five clinics in a month and year, housing type and the time (months and years).

Data on previous rainfall patterns and temperatures was obtained from the Provincial Agricultural Office to determine if there was a relationship between malaria and weather patterns. Data on malaria prevention promotions was also obtained from the District Hospital management office. Secondary data on malaria cases for the past three years (2015-2017) were collected and entered into SPSS v.16 for analysis. Linear regression was used to determine the relationship between malaria trends in under-five and weather patterns during the period under study (2015-2017). For categorical data, descriptive statistics, proportions and percentages were determined. Bar charts, scatter plots and frequency distribution tables were also used for data presentation.

4. Results and Findings

This chapter shows the findings on the prevalence of laboratory confirmed cases of malaria in under-five children, the areas of origin of under-five malaria cases, the trends of malaria cases in under-five children and the relationship between malaria trends and weather patterns.

Socio-Demographic

There were more females (52.6%) under-five children with malaria compared to the males (47.4%) **table 1**.

Table 1: Socio-Demographic Profile of Study Participants

Socio-demographic characteristic	Frequency (N = 384)	Percent (%)
Age (years)		
1 – 2	245	63.8
>2	139	36.2
Sex of baby		
Male	182	47.4
Female	202	52.6
Village		
Mwewa	54	14.0
Chofwe	50	13.0
Maipambe	64	16.7
Others	216	56.3

Prevalence of Laboratory Confirmed Malaria Cases for 3 Years

The highest prevalence of malaria cases (4.5 cases per 1000 population) among under-five children occurred in 2017 than the other years **figure 1**.

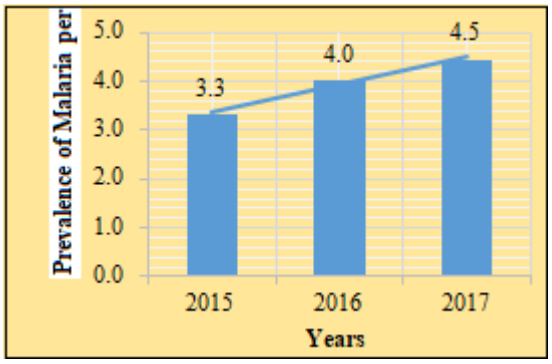

Figure 1: Prevalence of Laboratory Confirmed Malaria Cases for 3 Years

Trends in Malaria Cases for 3 Years

The trends in malaria cases were occurring more in female under-five children compared to males accept in 2017 when the number of males were higher than females **figure 2**.

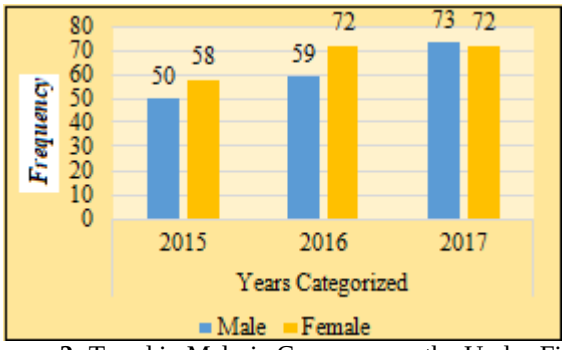

Figure 2: Trend in Malaria Cases among the Under-Five Children for 3 Year.

Areas of Origin of Malaria Cases for 3 Years

Maipambe village recorded the highest number of malaria cases than the rest of the villages **figure 3**.

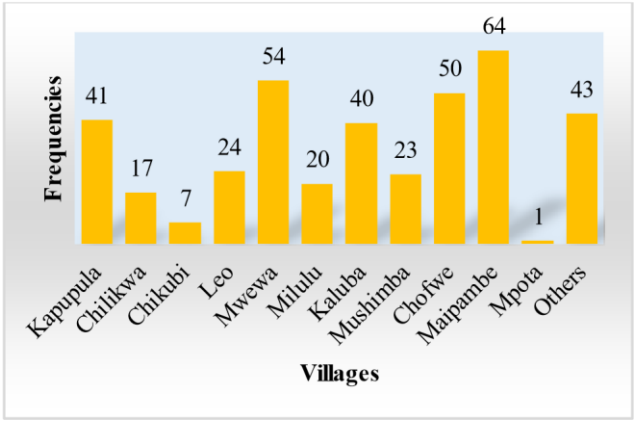

Figure 3: Malaria Cases in the Villages of Chipili Area

Weather patterns and monthly malaria cases for 3 years (2015 – 2017)

Temperature trends were compared to monthly malaria cases. There was a correlation between monthly malaria cases and temperature **Figure 4, 5 & 6**.

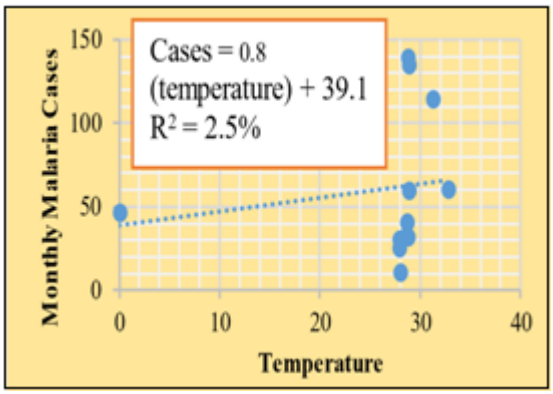

Figure 4: Scatter plot for monthly malaria cases against temperature in 2015

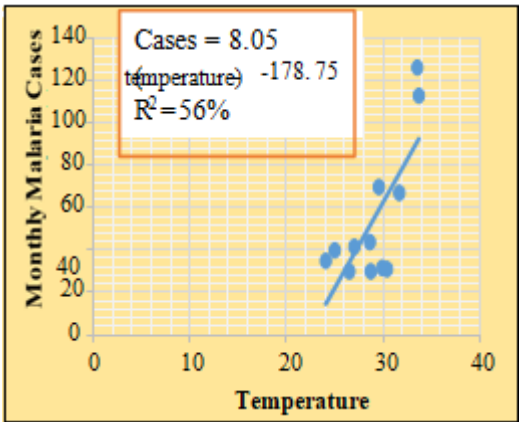

Figure 5: Scatter plot for monthly malaria cases against temperature in 2016

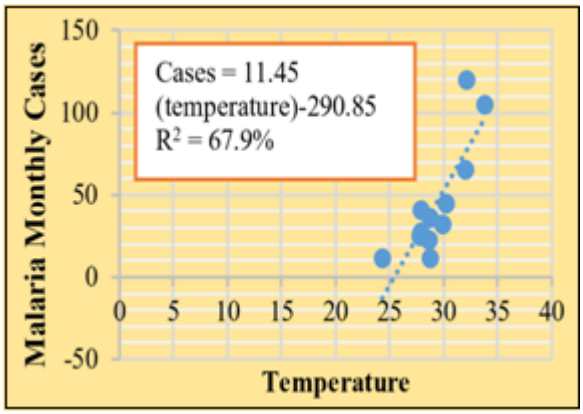

Figure 6: Scatter plot for malaria cases against monthly temperature in 2017

Linear regression coefficients for the weather patterns and monthly malaria cases for 3 years (2015 – 2017)
There was a positive correlation between monthly malaria cases and temperature **table 2.**

Table 2: Linear regression coefficients for malaria cases against monthly temperature by year

Malaria Cases against Temperature 2016				
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-178.7464287	65.8462764	-2.7146	0.021761031
Temperature	8.048657517	2.255729399	3.568095	*0.005111916
Malaria Cases against temperature in 2015				
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-290.8470446	73.37169186	-3.96402	0.002669019
Temperature	11.45377387	2.490915294	4.598219	*0.000982797
Malaria Cases against Temperature 2017				
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	39.17171735	45.21484985	0.866346288	0.406607
Temperature	0.814163469	1.618813836	0.502938294	**0.625899

* ***Significant***
****Not significant***

5. Discussion

Prevalence and Trends of Laboratory Confirmed Cases of Malaria in Under-Five Children from 2015 – 2017
The focus of the study was to determine the prevalence of laboratory confirmed malaria cases in under-five children from 2015-2017 at Chipili Rural Health Center. Prevalence rate from 20152017 was found to be 3.3 cases per 1000 under-five children, 4.0 cases per 1000 under-five children and finally 4.5 cases per 1000 under-five children respectively. Secondly, the study was to determine the trends of malaria case in under-five children from 2015-2017 and from the above figures it is clear that the number of malaria cases has been increasing overtime. Furthermore, females were the most affected by malaria in the first 2 years. Cases for males only exceeded that of females in the year 2017. It was also observed that all the cases for both sex categories were increasing starting from year 2015 to year 2017 with an exception for the female category as the number cases remained the same from 2016 – 2017.

The increase in malaria cases observed in this study could be explained by the existing variation in weather patterns that have occurred overtime in this area. Changes in temperature and rainfall patterns can have a significant impact on the proliferation of mosquitoes by increasing the breeding sites for mosquitoes. Given these changes, in the absence of insecticide treated nets use and indoor residual spraying, malaria incidence is likely to be on the rise. This is no surprise considering the fact that climate change is a

reality that will ultimately create an upsurge in vector borne diseases such as malaria. Through climate change we should expect unusual warming and seasonal fluctuations which will affect malaria incidence rates [22]. As evidence from this assertion and [22] found in their study that climate change does indeed have a positive influence on malaria incidence. However, it is worth noting that finding is inconsistent with that found in Lusaka Province in the period of 2009 – 2013. From that study, it was observed that the trend of malaria for the past 5 years has shown a general reduction in both mortality and morbidity [20]. Similarly, in a study conducted by [23] data exhibited three distinct epidemiological divisions after a significant malaria reduction (66%) in malaria cases and deaths, between the years 2000 and 2008. These changes occurred following the continued and renewed support for the extension of indoor residual spraying up to 90% coverage, scale-up of coverage of long-lasting insecticide treated nets in household from 50% to 70%, and artemisinin-based combination therapy nationwide. Thus given this finding it is clear that despite the interventions put up by Ministry of Health through Chipili District medical office such as distribution of insecticide treated mosquito nets (ITNs) to pregnant mothers and under-five children and indoor residual spraying (IRS) there has been an observed increase in the malaria morbidity in Chipili catchment area as well as the vast number of villages being affected which can be attributed to the fact that people do not use the treated nets given to them or they refuse their houses to be sprayed.

Findings from this study indicate that most of the under-five children affected were females. Results from this study could be explained by the fact that female children may be biologically more susceptible to infectious diseases compared to their male counterparts. However, this is inconsistent with the findings arrived at in Ghana in a study to assess socio-demographic factors and their relation with malaria. From this study the researchers found that most of the male children experienced more malaria cases than their female counterparts [24]. This could possibly be confounded by other factors such as variations in regional conditions.

Areas of Origin of Malaria Cases from 2015 – 2017

The other objective of the study was to identify the areas of Origin of under-five malaria cases from 2015- 2017. The results showed that most of the cases reported from the villages, came from Maipambe with 64 cases, followed by Mwewa with 54 and Chofwe with 50. The villages with the lowest malaria cases were Mpota which recorded 1case of malaria and Chikubi with 7 cases. The fact that Maipambe recorded the highest could be that it is near the health Facility or clinic meaning that other villages which are far from the clinic failed to report the cases due to transport cost and long distance coverage area to reach to the Health Center and hence opted to use traditional medicine whenever they suspected that the child was sick. And the other reason could be that those near the health Center mostly interact with the health care providers almost on a daily basis hence feel the need to take the child to the clinic whenever they suspect that the child was unwell.

The variations in the number of malaria cases could also be explained by the difference in the environment and housing. It is also worth noting that the study area where all malaria cases were obtained is in a rural area. Region or place has a significant role to play in the proliferation of mosquitoes as well as creating conditions that favor growth of the malaria causing parasites. In favor of the aforementioned [25] found the environment is an important exposure factor for malaria incidence; after rainfall there is water accumulation in buckets, old tires, or containers, conditions that create appropriate breeding sites for mosquitoes. Weeds, overgrown grasses and bushes can also contribute to breeding sites hence increasing malaria transmission possibilities.

Referring to housing and its impact on under-five malaria incidence a study in Nigeria concluded that poor housing conditions predicted malaria incidence among under-five children in Nigeria [26]. Similarly, researchers have reiterated this idea explaining that living in better-quality houses could explain eradication of malaria in the United States and its reduction in Europe [26]. In fact, a study in Gambia found that improved housing conditions have the potential to lower the odds of malaria infection and clinical malaria up to 42% and about 54–65% respectively [27].

Chipili district is a rural area currently undergoing development and so it is expected that most of these people in this area are poor. In fact, most of these rely on farming and fishing as a source of income. This partly explains why most of the villages in this area are not exempted from the scourge of malaria. Supporting this reality, a randomized survey on fishing with bed nets in Lake Tanganyika found that use of bed nets was frequent and a common practice along Lake Tanganyika [28]. Possible reasons for this could be due to the need for a source of income that comes with a huge catch of fish. However, such as a situation could imply that most of people living near the rivers and lakes do not use insecticide treated mosquito nets. Commenting on their finding [28] point out that "this observation raises concerns that this practice may also be occurring in other waterside communities in sub-Saharan Africa."

Highlighting the significance of poverty, the [29] points out that the poorest in a given society tend to experience the highest rates of malaria in a given region and are also the least likely to sleep under bed nets and yet it is these same families that are battling serious concerns, such as hunger. Economic pressures have the potential to affect malaria prevention and so it is more likely to be the case that behavior change will not happen until those affected are relieved from such pressures [30].

Correlation between weather patterns and monthly malaria cases for past 3 years (2015 – 2017)

The results obtained shows that malaria is positively correlated with temperature in 2015 and 2016 (p-value=0.005 and p-value= 0.001) respectively. Malaria cases significantly increased with the monthly temperature of the area of study. In the year 2015 it was observed that for every unit increase in temperature there was an 11.45 increase in the number of malaria cases (p value = 0.0009). These results show that as the temperature increased, malaria cases also increased. This could be attributed to the

fact that malaria transmission is strongly influenced by environmental factors such as temperature and rainfall and in this case the increasing temperature accelerated the rate of mosquito larva development. Hence these findings coincided with the study that was done by [31] which proved that the development of mosquito larva depended on temperature and that as the temperature increased the number of blood meals taken and the number of eggs laid by mosquitos in a given area also increased. The study done by [32] also shows that temperature fluctuations have profound impact on predictions of mosquitos and malaria parasite development time and fluctuations may either increase or decrease malaria risk hence at higher temperature the risk of getting malaria was high compared to lower temperatures where breeding of mosquitoes was low.

The current study on the other hand, shows that in the year 2017 there was no positive correlation between monthly malaria cases and temperature (p value = 0.626). This means that despite the increase in temperature there was no significant effect on the number of malaria cases recorded and this could be attributed to the fact that temperature does not directly cause malaria but might increase the risk of one getting malaria.

Hence the findings from 2017 are in contrast with other studies which showed that there was a positive correlation between temperature and malaria.

6. Conclusion

There has been huge investment by government to control malaria infection in the past few years yet infection rates still keep on increasing especially in rural parts of Zambia that are highly endemic like Luapula province and the most vulnerable are pregnant women and under-five children. The study shows that the prevalence of laboratory confirmed cases of malaria in under-five children at Chipili Rural Health Centre from 2015 – 2017 has been increasing. Furthermore, females were the most affected by malaria in the first 2 years. Cases for males only exceeded that of females in the year 2017. It was also observed that all the cases for both sex categories were increasing starting from year 2015 to year 2017 with an exception for the female category as the number of cases remained the same from 2016 – 2017. The majority of the cases were reported from Maipambe, followed by Mwewa and Chofwe. Finally, there was a positive correlation between monthly malaria cases and temperature.

7. Future Scope

There is need to ascertain the relationship between sex and malaria in under-five children.Further research is also needed to investigate why under-five children and pregnant women are more vulnerable to malaria especially in rural areas.

References

[1] Howes, R.E., et al., *Plasmodium vivax transmission in Africa.* PLoS neglected tropical diseases, 2015. **9**(11).
[2] Roucher, C., et al., *A 20-year longitudinal study of Plasmodium ovale and Plasmodium malariae prevalence and morbidity in a West African population.* PLoS One, 2014. **9**(2).
[3] Sinka, M.E., et al., *The dominant Anopheles vectors of human malaria in the Americas: occurrence data, distribution maps and bionomic précis.* Parasites & vectors, 2010. **3**(1): p. 72.
[4] Rowe, A., et al., *Plasmodium falciparum rosetting is associated with malaria severity in Kenya.* Infection and immunity, 1995. **63**(6): p. 2323-2326.
[5] Gething, P.W., et al., *Mapping Plasmodium falciparum mortality in Africa between 1990 and 2015.* New England Journal of Medicine, 2016. **375**(25): p. 2435-2445.
[6] Organization, W.H., *Harmonization of rapid diagnostic tests for malaria and implications for procurement: meeting report: 26–27 February 2015, Geneva, Switzerland.* 2015.
[7] Health, M.o.H, *National Health Strategic Plan 2011 – 15*, M.o.H. Health, Editor. 2011, Ministry of Health: Lusaka. Zambia.
[8] Health, M.o.H, *Health Management Information System (HMIS)*, M.o.H health, Editor. 2015, Ministry of health: Lusaka Zambia.
[9] Inambao, A., et al., *Malaria incidence in Zambia, 2013 to 2015: observations from the Health Management Information System.* Health Press Zambia Bull, 2017. **1**(3): p. 11-21.
[10] Steketee, R.W., et al., *National malaria control and scaling up for impact: The Zambia experience through 2006.* The American journal of tropical medicine and hygiene, 2008. **79**(1): p. 45-52.
[11] Masaninga, F., et al., *Review of the malaria epidemiology and trends in Zambia.* Asian Pacific journal of tropical biomedicine, 2013. **3**(2): p. 89-94.
[12] Yakoob, M.Y., et al., *Preventive zinc supplementation in developing countries: impact on mortality and morbidity due to diarrhea, pneumonia and malaria.* BMC Public health, 2011. **11**(3): p. S23.
[13] Chilton, M., M. Chyatte, and J. Breaux, *The negative effects of poverty & food insecurity on child development.* Indian Journal of Medical Research, 2007. **126**(4): p. 262.
[14] Charman, S.A., et al., *Synthetic ozonide drug candidate OZ439 offers new hope for a single-dose cure of uncomplicated malaria.* Proceedings of the National Academy of Sciences, 2011. **108**(11): p. 4400-4405.
[15] Health, M.o.H, *Malaria Operational Plan* M.o. H Health, Editor. 2016, Ministry of Health: Lusaka Zambia.
[16] Korenromp, E.L., et al., *Impact of malaria control on childhood anaemia in Africa–a quantitative review.* Tropical Medicine & International Health, 2004. **9**(10): p. 10501065.
[17] UNICEF. and G.P.t.R.B. Malaria, *Malaria: a major cause of child death and poverty in Africa*. 2004: UNICEF.

[18] Organization, W.H., *Guidelines for the treatment of malaria*. 2015: World Health Organization.
[19] Organization, W.H., *World malaria report 2014. Geneva: WHO; 2014.* Fecha de consulta, 2018. **23**: p. 247.
[20] Kalubula, M., et al., *An assessment of epidemiological trends of malaria in Lusaka Province of Zambia, 2009-2013.*
[21] Epidemiology: Open Access, 2015. **5**(3).
[22] Lin, E., et al., *Differential patterns of infection and disease with P. falciparum and P. vivax in young Papua New Guinean children.* PloS one, 2010. **5**(2).
[23] Kurup, R., G. Deonarine, and A.A. Ansari, *Malaria trend and effect of rainfall and temperature within Regions 7 and 8, Guyana.* International Journal of Mosquito Research, 2017. **4**(6): p. 48-55.
[24] Chanda-Kapata, P., et al., *A retrospective evaluation of the quality of malaria case management at twelve health facilities in four districts in Zambia.* Asian Pacific journal of tropical biomedicine, 2014. **4**(6): p. 498504.
[25] Nyarko, S.H. and A. Cobblah, *Sociodemographic determinants of malaria among under-five children in Ghana.* Malaria research and treatment, 2014. **2014**.
[26] Musoke, D., M.B. Musoke, and W. Nsubuga, *Factors associated with prevention of malaria and other diseases transmitted by mosquitoes at household level in Wakiso District, Uganda.* 2013.
[27] Morakinyo, O.M., F.M. Balogun, and A.F. Fagbamigbe, *Housing type and risk of malaria among under-five children in Nigeria: evidence from the malaria indicator survey.* Malaria journal, 2018. **17**(1): p. 311.
[28] Pinder, M., et al., *The RooPfs study to assess whether improved housing provides additional protection against clinical malaria over current best practice in The Gambia: study protocol for a randomized controlled study and ancillary studies.* Trials, 2016. **17**(1): p. 275.
[29] McLean, K.A., et al., *Fishing with bed nets on Lake Tanganyika: a randomized survey.* Malaria journal, 2014. **13**(1): p. 395.
[30] Parker, D.M., et al., *Malaria ecology along the Thailand–Myanmar border.* Malaria journal, 2015. **14**(1): p. 388.
[31] Stratton, L., et al., *The persistent problem of malaria: Addressing the fundamental causes of a global killer.* Social science & medicine, 2008. **67**(5): p. 854-862.
[32] Sultana, M., et al., *Prevalence and associated determinants of malaria parasites among Kenyan children.* Tropical medicine and health, 2017. **45**(1): p. 25.
[33] Beck-Johnson, L.M., et al., *The importance of temperature fluctuations in understanding mosquito population dynamics and malaria risk.* Royal Society open science, 2017. **4**(3): p. 160969.