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Research Article

The Effects of Climate Change Atmospheric Temperature, Rainfall Pattern and Land Use Malaria Incidence Rates: A Retrospective Trend Analysis over a Ten-Year Period 2010-2020 in Luapula and Southern Zambia

Joshua Kanjanga Phiri*, **Rosemary Ndonyo Likwa**

Department of Population Studies and Global Health, University of Zambia, Lusaka, Zambia

ABSTRACT

This study examines the impact of climate change on the incidence of malaria in Zambia. The study focused on variations in prevalence influenced by climatic and environmental factors. This study adopted a retrospective comparative analytical approach utilizing 157 case records from each province. The survey investigated temperature, rainfall seasonal variations, and land use activities. The findings revealed a fluctuating trend in rainfall from 2010-2020, with a significant association between malaria incidence and rainfall (p value=0.041). In 2019, southern provinces experienced the highest percentage of drought (64%), resulting in reduced malaria transmission due to unfavorable environmental conditions for mosquito larvae. Demographic data highlight an urban-rural divide, with Luapula Province exhibiting a greater number of malaria cases among children under five years of age compared with the Southern Zambia. These results emphasize the critical role of climate change and local factors in malaria transmission dynamics.

Keywords: Climate change; Malaria incidence; Zambia; Prevalence; Climatic factors; Environmental factors; Case records; Temperature

INTRODUCTION

Climate change, characterized by shifts in global or regional climate patterns, has been attributed to increased atmospheric carbon dioxide from fossil fuel usage. This has led to various incremental health impacts over the past quarter-century. The resulting extreme weather events, such as floods, aridity, and heatwaves, directly affect human populations and indirectly contribute to unprecedented variations in disease patterns due to alterations in ecology and biotic systems [1].

Malaria, a pervasive parasitic disease, poses a substantial global health threat. Approximately 214 million cases and 438,000 deaths were reported worldwide in 2015, with Africa being the predominant region affected. The World Health Organization (WHO) warns that climate change could lead to an additional quarter of a million deaths annually by 2030-2050. This is attributed to malnutrition, malaria, diarrheal diseases, and heat stress [2]. Climate change patterns have already impacted malaria transmission in sub-Saharan Africa, which has the highest malaria burden. Other regions at risk include the Mediterranean, Southeast Asia, the Western Pacific, and the Americas. Notably, the top 11 countries contributing 85% of the global malaria burden, with the top six contributing more than 50%, are all located in sub-Saharan Africa [1].

Malaria is caused by five different parasites, with *P. falciparum* being the dominant species in Africa and accounting for the highest mortality worldwide [3]. The vector-borne nature of malaria underscores the significance of eco-environmental factors, including climate and landscape, in influencing both vector and parasite development and community exposure [4].

In Zambia, variations in malaria incidence persist across the country despite progress in some regions, such as the southern province. These variations are influenced by climate variables such as low altitude, high NDVI, and land surface temperature [5,6]. The challenges faced by Zambia in malaria control, including a reversal in efforts in 2009-2010 due to decreased donor funding, emphasize the interconnectedness of socioeconomic factors and climate-induced health impacts [7].

MATERIALS AND METHODS

This was a retrospective comparative study designed over 10 years

Correspondence to: Joshua Kanjanga Phiri, Department of Population Studies and Global Health, University of Zambia, Lusaka, Zambia, E-mail: joshuaphiri65.com@gmail.com

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in two provinces of Zambia. In this study, the patients were from Luapula Province, which has the highest incidence rate of malaria, while the control or comparison province was the southern province, which has the lowest incidence rate. The provinces were matched according to climatic variables to seasonal rainfall patterns, atmospheric air temperature, and man-made environmental activity. Therefore, this study will be conducted to determine the trends in malaria burden during the past 10 years at health centres in Luapula and southern provinces. The study population for the study included all individuals with suspected malaria who had visited the health centres for the first time from January 2010 to December 2020.

Data extraction

This comprehensive retrospective record review, spanning the years 2010 to 2020, employed diverse parameters, including the date of examination and the total number of clinically treated and confirmed malaria cases on a monthly and yearly basis [8]. The data collection involved interactions with municipal councils in each district, ensuring validation through observation [9]. The epidemiological data, crucially focusing on confirmed cases, were sourced from Zambia's Ministry of Health (MoH) *via* the National Malaria Elimination Centre (NMEC), emphasizing the reliance on laboratory diagnostic tests or Rapid Diagnostic Test (RDT) results since 2010 [10]. Acknowledging the impact of local environmental factors on vector abundance and the significance of incident malaria cases in identifying residual transmission, environmental variables were obtained from satellite-based imagery datasets [11]. Climatic variables, particularly daily precipitation data and temperature variations, were acquired from the Zambia Meteorological Agency. The choice of primary climate variables, temperature and rainfall, was guided by a robust body of literature demonstrating their substantial influence on both short- and long-term changes in malaria transmission [12-16].

Data collection

The data collected for this study were entered into the Microsoft Office Excel Worksheet 2010 and analyzed using STATA version 14 [17]. Descriptive statistics were used to calculate overall malaria incidence and trends in malaria transmission, with graphs generated to illustrate these trends over the ten-year study period [18]. Parametric and nonparametric statistical analyses were used to detect trends in climatic variables and determine the effects of climatic and sociodemographic factors on age-specific malaria incidence and control interventions [19]. Linear regression tests were implemented to explore trends and changes in trends and to regress malaria against environmental and intervention variables. This study specifically investigated the potential role of climate variables in malaria transmission dynamics at the subnational district level in Zambia from 2010 to 2020 [20]. Linear regression was also performed to assess the significance of malaria incidence trends over time, correlating malaria incidence rates with climatic variables such as temperature and rainfall. The land surface temperature, measured as the mean minimum, mean maximum, and mean average temperature for each month, was considered in this analysis. Pearson correlation coefficients were calculated to determine the association between malaria incidence and the selected climatic variables [21]. Additionally, larval control, a key aspect of the integrated malaria control approach in the two provinces, involved environmental management and chemical use. Understanding the environmental characteristics influencing the larval activity of principal malaria vectors was emphasized in the context of larval control as part of a broader vector management program [22].

Data analysis

The section shows the association between malaria incidence and climatic variables. After the data were cleaned with Excel, the data were imported and analyzed using Stata version 14.0. In the bivariate analysis, logistic regression was used to assess the association between categorical variables and outcomes. Variables that were statistically significant at the 5% level. This study intends to compare and establish the effects of climatic change on malaria incidence rates over a ten-year period from 2010 to 2020 in selected provinces of Luapula and southern provinces in Zambia. Furthermore, this chapter discusses the demographic characteristics of malaria incidence and how changes in climatic and environmental variables influence the incidence of malaria.

The Figure 1 below compares the different trends in the incidence of malaria between the two provinces. For the southern province, the incidence rate increased by 2013 and 2014 and then decreased after 2015 as shown in Figure 2. Thereafter, a sharp increase was recorded in 2019. In addition, only the increases observed for Luapula Province occurred in 2010 and 2016; since then, they appear to have decreased in the different years at all ages as shown in Figure 3.

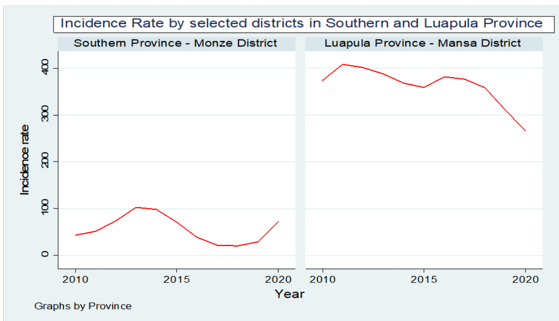

Figure 1: Relationship of malaria incidence rates.

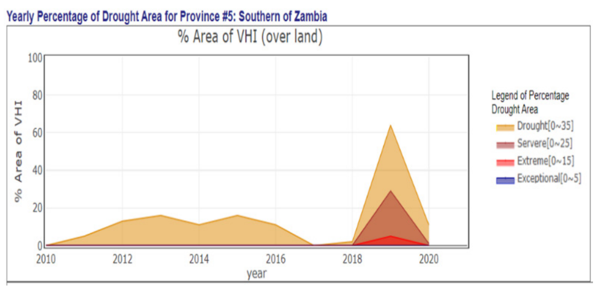

Figure 2: Percentage of drought in southern provinces. **Note:** Percentage drought area: ( ): Drought (0~35); ( ): Servere (0~25); ( ): Extreme (0~15); ( ): Exceptional (0~5).

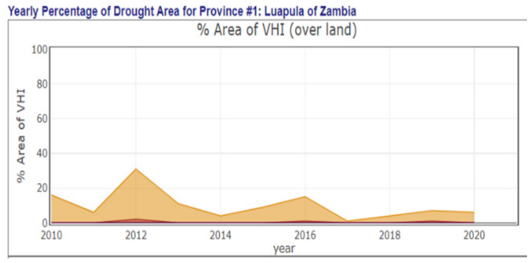

Figure 3: Drought Luapula percentage. **Note:** Percentage drought area: (▬): Drought (0~35); (▬): Servere (0~25); (▬): Extreme (0~15); (▬): Exceptional (0~5).

The results of the averaged VHI for Luapula Province showed that there was a positive correlation between land and vegetation. Furthermore, the data showed that there was a fluctuating trend in vegetation availability over the 10-year period, as shown in Figure 4.

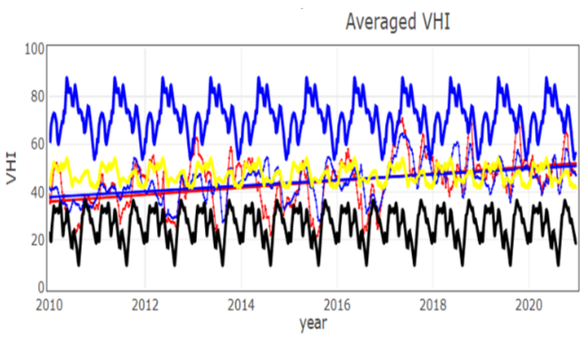

Figure 4: Average VHI of Luapula Province. **Note:** (▬): Cropland; (▬): y=1.4585x+-2895.6123; (▬): Land; (▬): y=1.1871x+-2348.2036; (▬): Max; (▬): Min; (▬): Mean.

RESULTS AND DISCUSSION

The study conducted in Luapula and southern provinces of Zambia over a ten-year period from 2010 to 2020 sheds light on the intricate relationships among climate change, environmental factors, and malaria incidence. In Luapula Province, a positive correlation was observed between malaria incidence rates and maximum and minimum temperatures as shown in Tables 1 and 2. This positive association reflects the broader trend of climate change, with rising temperatures potentially facilitating the spread of malaria [22]. Furthermore, the negative correlation between malaria incidence and daily precipitation indicates that reduced rainfall is linked to increased malaria incidence. This aligns with the adverse effects of climate change, which include decreased precipitation and its impact on malaria transmission [2]. This study also highlights the influence of climate change on rainfall patterns, which has led to fluctuations over the years in Luapula Province. These fluctuations may be attributed to changing climate conditions, which affect malaria dynamics.

The effects of climate change on the malaria incidence rate in relation to rainfall and temperature variation patterns in Zambia over a ten-year period beginning in 2010

Luapula province: The results of the Pearson correlation test revealed a strong positive (0.043) correlation between the malaria incidence rate and maximum temperature. There was also a positive correlation (0.152) between the malaria incidence rate and minimum temperature. Similarly, there was a negative correlation (-0.623) between the malaria incidence rate and daily precipitation (mm) corrected between 2010 and 2020. Furthermore, analysis also indicated that there was a strong association between the malaria incidence rate and daily precipitation corrected between 2010 and 2020, with a p value of 0.041, which was statistically significant at 0.05. The data analysis also revealed a negative (-0.608) correlation between the malaria incidence rate and annual rainfall. The Pearson correlation coefficient also revealed a strong association between the malaria incidence rate and annual rainfall, with a p value of 0.047 indicating statistical significance at 0.05.

Studies, such as those conducted by Ashton, have also highlighted the positive relationship between temperature and malaria incidence [21,22]. Increasing temperatures can extend the geographical range of malaria vectors and accelerate the spread of the malaria parasite within mosquitoes, potentially leading to increased malaria transmission. The inverse relationship between malaria incidence and daily precipitation has been documented in previous studies, emphasizing the role of water availability in creating suitable breeding habitats for mosquito vectors. Reduced precipitation can lead to the creation of stagnant water bodies that are ideal for mosquito larvae to thrive [3]. The strong association between malaria incidence and annual rainfall, as indicated by the significant p value, underlines the importance of understanding long-term precipitation patterns in malaria-endemic regions. Such patterns can provide insights into the likelihood of malaria outbreaks, especially in areas where rainfall is a key driver of mosquito breeding, as supported by research on climate and malaria transmission dynamics [1,21]. As a result, this study further revealed a high fluctuating trend in rainfall that was recorded from 2010-2020, with a 1058.0 mm mean annual rainfall, and the maximum total rainfall was observed in 2017 (1434.4 mm), while the minimum rainfall was observed in 2016 (801.6 mm). The results obtained showed an association between monthly malaria cases and the climatic/meteorological variables temperature and rainfall [23,24].

Table 1: Environmental human activities influences climate change and the malaria incidence rates in Mansa district of Luapula province of Zambia.

Autocorrelation among Meteorological factors in Mansa district of Luapula province						
Variables	RH at 2 m	Maximum temperature	Minimum temperature	Mean temperature	Minimum precipitation	Annual rainfall
RH at 2 m	1	-0.524	-0.561	0.139	-0.657*	0.657*
Max temperature	-0.524	1	-0.007	0.598	-0.679*	-0.667*
Min temperature	-0.561	-0.007	1	-0.806**	0.093	0.077
Mean temperature	0.139	0.598	-0.806**	1	-0.477	-0.456

Min precipitation	0.657*	-0.679*	0.093	-0.477	1	0.998**
Annual rainfall	0.657*	-0.667*	0.077	-0.456	0.998**	1

Note: *: Correlation is significant at the 0.05 level (2-tailed); **: Correlation is significant at the 0.01 level (2-tailed).

Table 2: Environmental human activities influences climate change and the malaria incidence rates in Monze district of Southern province of Zambia.

Autocorrelation among Meteorological factors in Monze district of Southern province						
Variables	RH at 2 m	Maximum temperature	Minimum temperature	Mean temperature	Minimum precipitation	Annual rainfall
RH at 2 m	1	-0.14	0.322	-0.339	0.813**	0.778**
Max temperature	-0.14	1	-0.049	0.58	-0.147	-0.212
Min temperature	0.322	-0.049	1	-0.842**	-0.004	-0.024
Mean temperature	-0.339	0.58	-0.842**	1	-0.077	-0.096
Min precipitation	0.813**	-0.147	-0.004	-0.077	1	0.993**
Annual rainfall	0.778**	-0.212	-0.024	-0.096	0.993**	1

Note: **: Correlation is significant at the 0.01 level (2-tailed).

Southern province: The Pearson correlation coefficient was calculated to determine the relationship between malaria incidence rates and meteorological/climatic factors. The results revealed that there was a negative correlation between the relative maximum temperature (-0.263) and minimum temperature (-0.276). On the other hand, there was a positive correlation (0.084) between the mean temperature and malaria incidence rate. There was also a strong positive correlation between malaria incidence rates and rainfall. The results from the Pearson correlation test between malaria incidence rates and daily precipitation corrected (mm/day) from 2010-2020 revealed that there was a positive correlation between malaria incidence rates and daily precipitation corrected (mm/day). Additionally, there was no statistically significant association between the Malaria incidence rate and minimum rainfall (mm/day), with a p value of 0.719 indicating a significant difference of 0.05.

This negative relationship indicates that as temperatures increase, the incidence of malaria tends to decrease. These findings are consistent with those of several previous studies, which have shown that extreme heat can negatively impact mosquito survival and reduce malaria transmission [25]. These findings contribute to the growing body of research investigating the links between meteorological and climatic factors and malaria incidence. These results reinforce the importance of considering these factors in malaria control strategies and adapting interventions to the specific weather conditions of different regions. Understanding the complex relationships between temperature and rainfall variables and malaria transmission is critical in developing effective and targeted measures for combating this disease, particularly in the face of climate change. The significance of these findings lies in their potential to inform evidence-based strategies for malaria prevention and control.

The role of climate change in the observed increase or decrease in Malaria in Zambia over a ten-year period from 2010-2020

The data analysis in this study revealed that there was a higher incidence of floods recorded in Luapula Province and a high incidence of droughts in the southern province of Zambia as of 2020. The results of the averaged VHI for Luapula Province showed that there was a positive correlation between land and vegetation.

Furthermore, the data showed that there was a fluctuating trend in vegetation availability over the ten-year period. However, Luapula Province is more prone to harboring larvae for mosquitoes with favorable or suitable environmental conditions for survival, whereas in the southern province, the high number of droughts recorded has impacted the vegetation health index, leading to harsh environmental conditions for the survival and harboring of mosquito larvae.

According to the data generated, the Vegetable Health Index for the yearly percentage of drought area for the province showed that in 2019, the southern province had the highest (64%) percentage of drought recorded during a ten-year period. In Luapula Province, the highest percentage recorded was 31% of the yearly percentage of drought area for the province, and drought was recorded in 2012.

Similarly, collected weekly malaria data from 2011 to 2013 and used the Normalized Difference Vegetation Index (NDVI), night surface temperature, rainfall, and night dew point to model health facility-level malaria transmission within the southern province. Their results revealed a significant association with environmental variables (dewing point, temperature, and NDVI) across low, moderate, and high transmission zones [24].

This study is important because of its contribution to the growing body of knowledge linking climate change, environmental conditions, and malaria transmission. By elucidating the distinct climate-related challenges faced by different regions within Zambia, this research provides critical insights for malaria control and adaptation strategies. Recognizing the impact of floods, droughts, and vegetation health on mosquito breeding and malaria transmission is vital for tailoring interventions to specific local conditions and effectively combating this disease in the context of a changing climate.

Role of environmental land use combined with climate change in the observed increase or decrease in Malaria incidence over a ten-year period from 2010-2020 in Zambia

The study revealed that in 2010, the southern province had 216 kha of tree cover, extending over 2.5% of its land area. In 2021, 1.96 kha of tree cover was lost, equivalent to 564 kt of CO_2 emissions. In 2010, Luapula had 2.13 Mha of tree cover, extending over 43% of its land area. In 2021, 20.6 kha of tree cover was lost, equivalent to 7.81 Mt of CO_2 emissions.

Furthermore, data obtained from ZamStats reveal that in Luapula Province, 194,520 people live in urban areas, while the majority of the population (797,407) lives in rural areas. In the southern province, 392,175 people live in urban areas, and 1,197,751 people (majority) live in rural areas.

As of 2020, many settlements in Luapula Province have an estimated population density of 20 per km^2; the total area of the province is 50,567 km^2 and characterized by its rural nature. In 2010, the total area of the southern province was 85,283 km^2, and the population density was 18.60 per km^2 [21]. These data imply that Luapula Province has a large surface area and vegetation that provide suitable conditions for mosquito larvae to survive, and the majority of the population lives in rural areas of the province and has more exposure to mosquito bites, as these areas have good VHIs that are between 40 and 60 over a ten-year period.

However, in the southern province, there is a poor vegetation health index with high records of droughts due to urban settlements and high cases of deforestation, which have led to poor environmental conditions that have affected the survival of mosquito larvae in these areas.

Furthermore, an example of a district-wide study was conducted in the Nchelenge district in Luapula Province using household-level cross-sectional surveys conducted every two months between 2012 and 2015 [25].

CONCLUSION

A study was conducted in Luapula and the southern provinces of Zambia from 2010-2020 highlights the intricate relationships among climate change, environmental factors, and malaria incidence. The findings revealed a positive correlation between malaria incidence rates and maximum and minimum temperatures, reflecting the broader trend of climate change. Additionally, a negative correlation was observed between malaria incidence and daily precipitation, indicating that reduced rainfall is linked to increased malaria incidence. This study also emphasized the influence of climate change on rainfall patterns, which has led to fluctuations over the years in Luapula Province.

The results further revealed that there was a strong association between the malaria incidence rate and annual rainfall, highlighting the importance of understanding long-term precipitation patterns in malaria-endemic regions. These findings support previous research showing a positive relationship between temperature and malaria incidence, as rising temperatures can facilitate the spread of this disease. The inverse relationship between malaria incidence and daily precipitation is also consistent with the findings of previous studies, emphasizing the role of water availability in mosquito breeding habitats.

The study's significance lies in its potential to inform evidence-based strategies for malaria prevention and control. By considering meteorological and climatic factors, interventions can be tailored to specific weather conditions, allowing for more effective measures against malaria transmission. Furthermore, the study highlights the impacts of floods, droughts, and vegetation health on mosquito breeding and malaria transmission, providing insights for adaptation strategies in the face of climate change.

Overall, this research contributes to the growing body of knowledge on the complex relationships among climate change, environmental conditions, and malaria transmission. These findings underscore the need for proactive measures to address these factors in malaria control efforts.

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REFERENCES

1. World Malaria Report 2019. World Heal Organ. 2019.
2. Severe Malaria. Trop Med Intern Heal. 2014;19(1):7-131.
3. Guidelines for Malaria Vector Control. World Heal Organ. 2019.
4. World Malaria Report 2015. World Heal Organ. 2015.
5. Reid HL, Haque U, Roy S, Islam N, Clements AC. Characterizing the spatial and temporal variation of malaria incidence in Bangladesh, 2007. Malaria J 2012;11(1):1-8.
6. National malaria elimination strategic plan 2015-2020. Nat Malaria Cont Prog. 2015.
7. Masaninga F, Chanda E, Chanda-Kapata P, Hamainza B, Masendu HT, Kamuliwo M, et al. Review of the malaria epidemiology and trends in Zambia. Asian Pacific J Trop Biomed. 2013;3(2):89-94.
8. Tompkins AM, Thomson MC. Uncertainty in malaria simulations in the highlands of Kenya: Relative contributions of model parameter setting, driving climate and initial condition errors. PLoS One. 2018;13(9):e0200638.
9. Abiodun GJ, Maharaj R, Witbooi P, Okosun KO. Modelling the influence of temperature and rainfall on the population dynamics of Anopheles arabiensis. Malaria J 2016;15(1):1-5.
10. Blanford JI, Blanford S, Crane RG, Mann ME, Paaijmans KP, Schreiber KV, et al. Implications of temperature variation for malaria parasite development across Africa. Scien Rep. 2013;3(1):1300.
11. Colón-González FJ, Tompkins AM, Biondi R, Bizimana JP, Namanya DB. Assessing the effects of air temperature and

rainfall on malaria incidence: An epidemiological study across Rwanda and Uganda. Geosp Heal. 2016;11(s1).

12. Krefis AC, Schwarz NG, Krüger A, Fobil J, Nkrumah B, Acquah S, et al. Modeling the relationship between precipitation and malaria incidence in children from a holoendemic area in Ghana. American J Trop Med Hyg. 2011;84(2):285.
13. Mohammadkhani M, Khanjani N, Bakhtiari B, Sheikhzadeh K. The relation between climatic factors and malaria incidence in Kerman, South East of Iran. Parasite Epidemiol Cont. 2016;1(3):205-210.
14. Odongo-Aginya E, Ssegwanyi G, Kategere P, Vuzi PC. Relationship between malaria infection intensity and rainfall pattern in Entebbe peninsula, Uganda. African Heal Scien. 2005;5(3):238-245.
15. Okuneye K, Gumel AB. Analysis of a temperature-and rainfall-dependent model for malaria transmission dynamics. Mathem Bioscien. 2017;287:72-92.
16. Suk JE. Climate change, malaria, and public health: Accounting for socioeconomic contexts in past debates and future research. Wiley Interdis Rev: Clim Chan. 2016;7(4):551-568.
17. Jackson MC, Kongoli C. Spatially explicit modelling of malaria in rural Zambia. PLoS One. 2014;9(11):e114168.
18. Smets S, Mwalubunju A, van Geertruyden JP, Vansteelandt S. A matched case-control study of the association between childhood malaria and acute renal failure in Malawi. PLoS One. 2013;8(5):e63668.
19. Bennett A, Yukich J, Miller JM, Keating J, Moonga H, Hamainza B, et al. The relative contribution of climate variability and vector control coverage to changes in malaria parasite prevalence in Zambia 2006-2012. Parasites Vect. 2016;9(1):1-2.
20. Molineaux L. The epidemiology of human malaria as an explanation of its distribution, including some implications for its control. Malaria: Prin Pract Malariol. 1988;2:913-998.
21. Grid. The impact of malaria control on endemic malaria in endemic countries: A comprehensive review. Malaria J 2017;16(1):163-175.
22. World Malaria Report 2008. World Heal Organ. 2008.
23. Shimaponda-Mataa NM, Tembo-Mwase E, Gebreslasie M, Achia TN, Mukaratirwa S. Modelling the influence of temperature and rainfall on malaria incidence in four endemic provinces of Zambia using semiparametric Poisson regression. Acta Tropica. 2017;166:81-91.
24. Nygren D, Stoyanov C, Lewold C, Månsson F, Miller J, Kamanga A, et al. Remotely-sensed, nocturnal, dew point correlates with malaria transmission in Southern Province, Zambia: A time-series study. Malaria J 2014;13(1):231.
25. Pinchoff J, Chaponda M, Shields TM, Sichivula J, Muleba M, Mulenga M, et al. Individual and household level risk factors associated with malaria in Nchelenge District, a region with perennial transmission: A serial cross-sectional study from 2012 to 2015. PLoS One. 2016;11(6):e0156717.