IMPACT OF WEATHER AND CLIMATE ON MALARIA INCIDENCE IN F.U.T. MINNA

SADIQ Abubakar and KINANG, Tabitha Yangnde
Phone: Sadiq 08069345502, Tabitha: 08179968704
Geography Department
Federal University of Technology, Minna.
Sadiq.abubakar@futminna.edu.ng, Tabykinang@gmail.com

ABSTRACT

Malaria is a vector-borne disease that affects millions of people worldwide, particularly in sub-Saharan Africa. Climate change has proven to be one of the key factors influencing the transmission of malaria, as it can affect the distribution, abundance, and behaviour of the female anopheles mosquito. This study aim to assess the influence of weather and climate on the occurrence of malaria and employed the use of quantitative data collection method and Pearson correlation analysis. Malaria and meteorological data were obtained from the Federal University of Technology, Minna clinics, and the Upper River Basin Authority over six years (2016-2021). The study revealed that the total rainfall received was about 8578.06mm with a 0.850 correlation value, depicting a significant level of impact of rainfall on the occurrence of malaria. The average monthly temperature was 31.12°c with a correlation value of 0.105, while the maximum relative humidity was about 87.880 with a correlation value of 0.072, both indicating a weak positive relationship on malaria occurrences. The study shows that the increase in temperature, humidity, and rainfall observed over the six years has influenced the abundance and distribution of the anopheles mosquito, which in turn has resulted in a higher incidence of malaria cases in the institution. Consequently, interventions aimed at mitigating the impact of malaria on students and staff such as the provision of insecticide-treated nets, indoor and outdoor spraying, awareness

campaigns, and environmental sanitation practices should be implemented around the school by the university authority.

Keywords: Malaria, Rainfall, Temperature, Relative Humidity, Climate change,

INTRODUCTION

Climate change is one of the most pressing issues facing our planet today, and its effects are being felt in many ways, including the spread of diseases such as malaria. It can influence the distribution and abundance of mosquitoes, as well as the transmission dynamics of the disease. In recent years, there has been a growing concern about the impact of climate variability on malaria occurrence, particularly in regions that are already highly endemic for the disease. As global temperatures continue to rise, the potential for the disease to spread to new areas and to become more severe in already affected regions is increasing. The World Health Organization estimates that in 2019, there were approximately 229 million cases of malaria worldwide, with over 400,000 deaths, and that the majority of these cases occurred in sub-Saharan Africa.

Understanding the relationship between climate variability and malaria occurrence is crucial for developing effective strategies for disease control and prevention. This research aims to investigate the effect of climate variability on the occurrence of malaria, focusing on how changes in temperature, rainfall, and other environmental factors may impact the transmission dynamics of the disease. Researchers have suggested that the persistence and resurgence of malaria outbreaks may be related directly or indirectly to global warming, a result of climate variability. The relationship between climate variability and the spread of malaria is still exceedingly convoluted and contentious. (Adewuyi, E. O., & Adefemi, K., 2016).

Adewuyi and Adefemi (2016), found that the occurrence of malaria and its severity in certain regions can be linked with the effects of climate variability. Their article suggests that the biology

of the plasmodium spp, the ecology of the mosquitoes, and even the susceptibility of humans to malaria could be influenced by climate variability. Climate variability may affect the availability and conditions for a disease's transmission environment, as well as the survival, procreation, and dissemination of the disease's pathogens and hosts. The health repercussions of such influences typically manifest as variations in the regional and seasonal patterns of infectious diseases that affect humans, as well as changes in the frequency and intensity of their outbreaks (wu, X., Lu, Y., & Zhou, S., 2016).

The word malaria is believed to have been used first by an Italian physician Francisco Torti (1658-1741), the word was derived from the Italian mal'aria literally "bad air," mala "bad" + aria "air" and it is often associated with marshes and swamps. (Smith *et al*, 2000). The plasmodium parasite, which causes malaria, is spread via the bite of infected mosquitoes. Based on the plasmodium species, the severity of malaria varies. Researchers are re-examining the long-standing connection between climate and disease from a global perspective as a result of evidence that the earth's climate is changing (Parry *et al*, 2007). The global hydrological cycle is also accelerated by global warming, which increases the intensity, frequency, and length of droughts as well as the frequency of heavy precipitation events and flooding (Parry *et al*, 2007). A variety of vector- and non-vector-borne diseases in humans and animals may be exacerbated and made more likely by these weather-related phenomena.

The Federal University of Technology, Minna is located in Bosso L.G.A. of Niger state. It has an enrolment range of between 15,000 – 19,999 students, and 5,000 staff; and like any other place in Niger state, it experiences two (2) distinct weather seasons i.e. the wet and the dry season within a year. The wet or rainy season usually begins in April and ends in October, with its peak rainfall in August and an average annual rainfall of about 1334mm. similarly, the average monthly

temperature is maximum in March at a temperature of 39^0C and minimal in August at 23^0C. the average monthly relative humidity is maximum in August at 60% and minimum in February at 19% respectively (Musa *et al.*, 2011)

The institution is challenged with the menace of anopheles mosquitoes like any other part of the country. Malaria is a significant public health problem in Nigeria, with approximately 50 million cases and 81,640 deaths reported annually (Dawaki *et al*., 2016). The increase in temperature and rainfall due to climate variability has contributed to an increase in the incidence of malaria in the study area, making it a cause for concern.

The multiplication of mosquitoes is one of the key causes of the increased frequency of malaria at the Federal University of Technology Minna. Anopheles mosquitoes are the principal vectors of malaria transmission, and they flourish in warm, humid environments. The increase in temperature and rainfall caused by climate change has increased the number of mosquitoes in the research area, resulting in a higher incidence of malaria.

METHOD AND METHODOLOGY

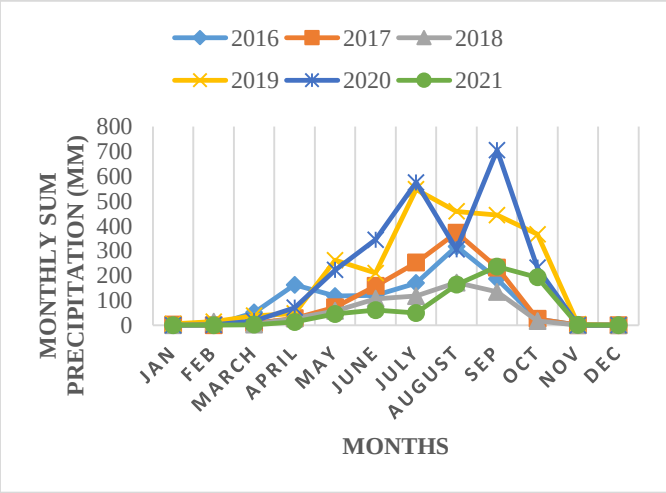
Malaria incidence data were gathered from two clinics at the Federal University of Technology, Minna. Malaria cases were counted in months over a 6-year period (72 months). The incidence of malaria in a specific month was independently assessed from succeeding months, while the meteorological data were gathered from the Upper Niger River Basin Authority and internet weather sources. Trends analysis of climatic conditions and malaria occurrence in F.U.T Minna was done using Excel data analytical tool. The Pearson Correlation was employed to examine the relationship between malaria occurrence and climatic variables throughout six years. This is a metric that quantifies the linear relationship between two variables. It is denoted by the symbol "r" and takes values between -1 and 1. A value of 1 indicates a perfect positive linear correlation,

which means that when one variable increases, the other variable increases proportionally. A value of -1 indicates a perfect negative linear correlation, which means that when one variable increases, the other variable decreases proportionally. A value of 0 indicates no linear correlation, which means that there is no relationship between the two variables.

RESULTS AND DISCUSSION

Descriptive Statistics

The climatic and malaria data acquired were processed to visualise the fluctuation and seasonal patterns through time-series analysis. The total monthly rainfall, average temperature, relative humidity, and malaria incidents were graphically represented in Figure 1. The graph (figure 1a) represents the rainfall data and shows a relatively uniform pattern over the six years under observation. It shows the gradual raise in rainfall from April and reaches its peak mostly in July, except in some rear cases (2020), where the entire country experienced a high amount of rainfall



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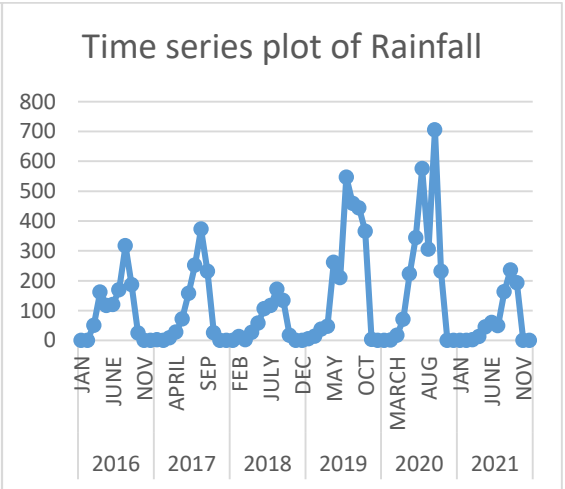

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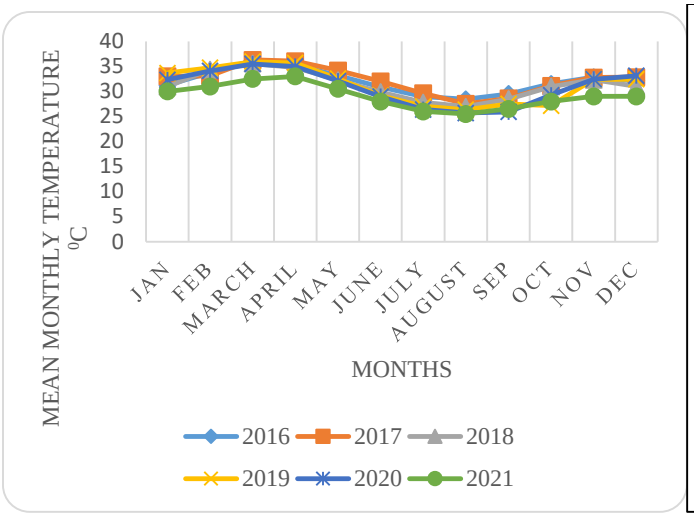

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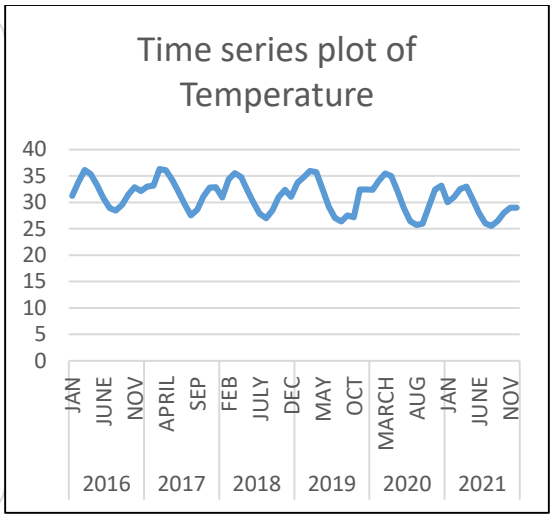

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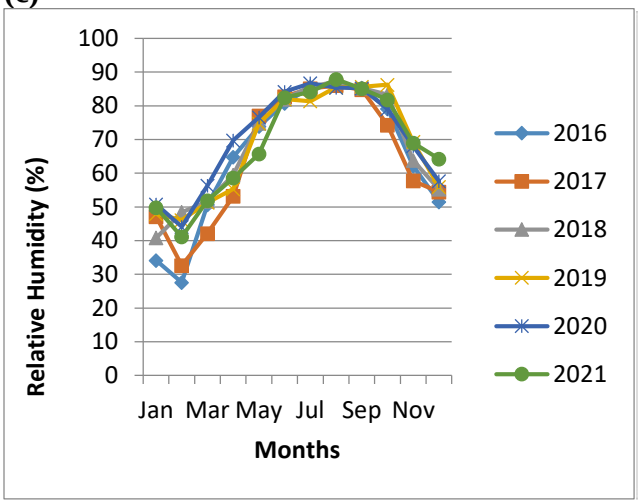

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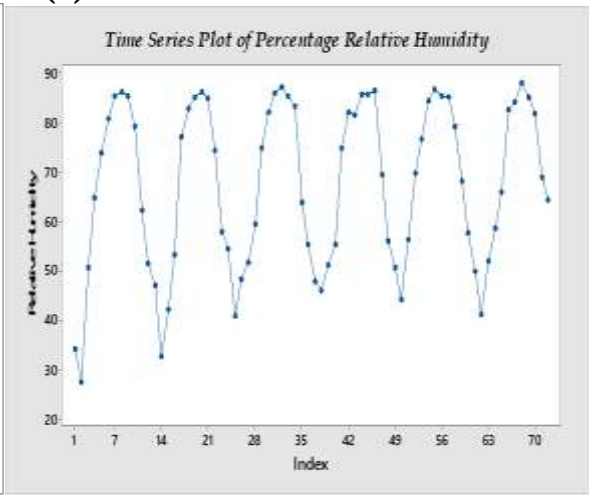

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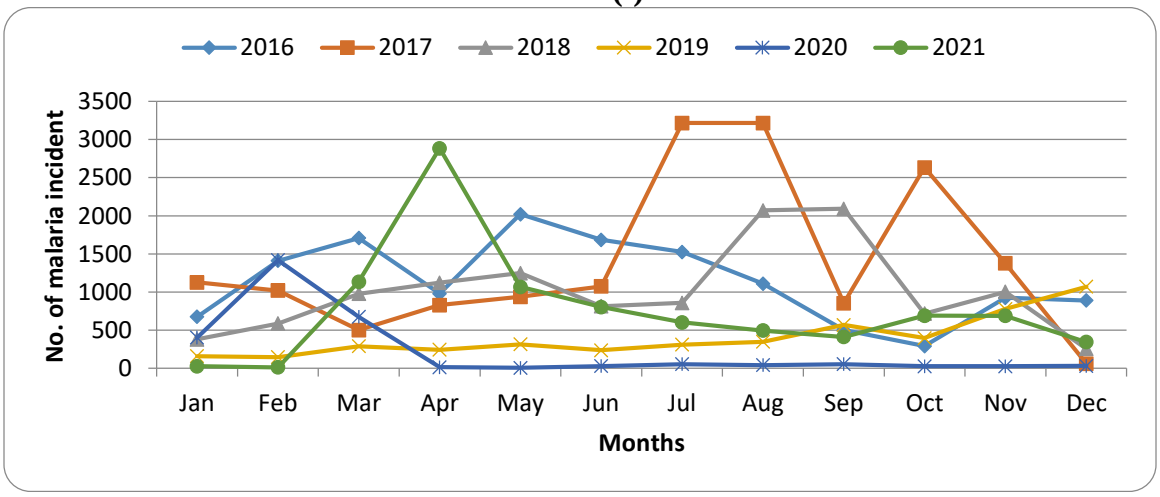

(g)

Figure 1: Monthly variation of rainfall, average temperature, relative humidity, and malaria reported cases in F.U.T. Minna (2016 – 2021).

(Over 700mm in September) that led to flooding that year. Figure 1b is a time-series plot of rainfall data that revealed the two main seasons in the study area (wet and dry season). The spikes in the graph represent the peak periods of rainfall while the lower troughs represent the dry seasons. The total amount of rainfall received during the six years is 8578.06mm, with a monthly average of 119.14mm.

An important determining element in mosquito reproduction and spread is temperature. The distribution of Minna's average monthly temperature from 2016 to 2021 (figure 1c) is very consistent from year to year. 36.290C was the highest temperature recorded during these times, and 25.50C was the lowest. With a monthly average temperature of 31.120C, the overall temperature during these times was 2240.57. The lowest readings of atmospheric temperature are recorded in June, July, August, and September, while the warmest readings are recorded in February, March, and April of each year, according to a time-series plot of atmospheric temperature (figure 1d). As the time series indicates, there was a significant decrease in atmospheric temperature in 2021 when compared to earlier years. This might be connected to the Covid-19 pandemic-related worldwide lockdown.

The relative humidity graph, (figure 1e) and the time-series plot shows that the highest percentage of relative humidity was 87.880% and the lowest is 27.56%. The total relative humidity from 2016-2021 is 4862.86% and an average percentage of 67.54. The result (figure 1f) revealed that the highest percentage of relative humidity seasonally occurred in June, July and a peak in August of every year.

From January 2016 to December 2021, the total number of malaria cases registered at both clinics in F.U.T. Minna was 58,551, with a monthly average case of 813 (figure 1g). The data reveals a noticeable seasonal variation. Malaria cases were found to be more prevalent during the wet season

than during the dry season. The data exhibits some rises and lower troughs during the wet season (June, July, and August) and the dry season (December, January, and February). Due to a strike by the Academic Staff Union of University (ASUU), which resulted in the absence of students at the institution, there was a major reduction, a sideways trend, and a marginally increasing trend in F.U.T. Minna clinics from 2018 to 2019. Similarly, there was a decrease in malaria incidence in 2020 as a result of the covid-19 epidemic and the nationwide lockdown.

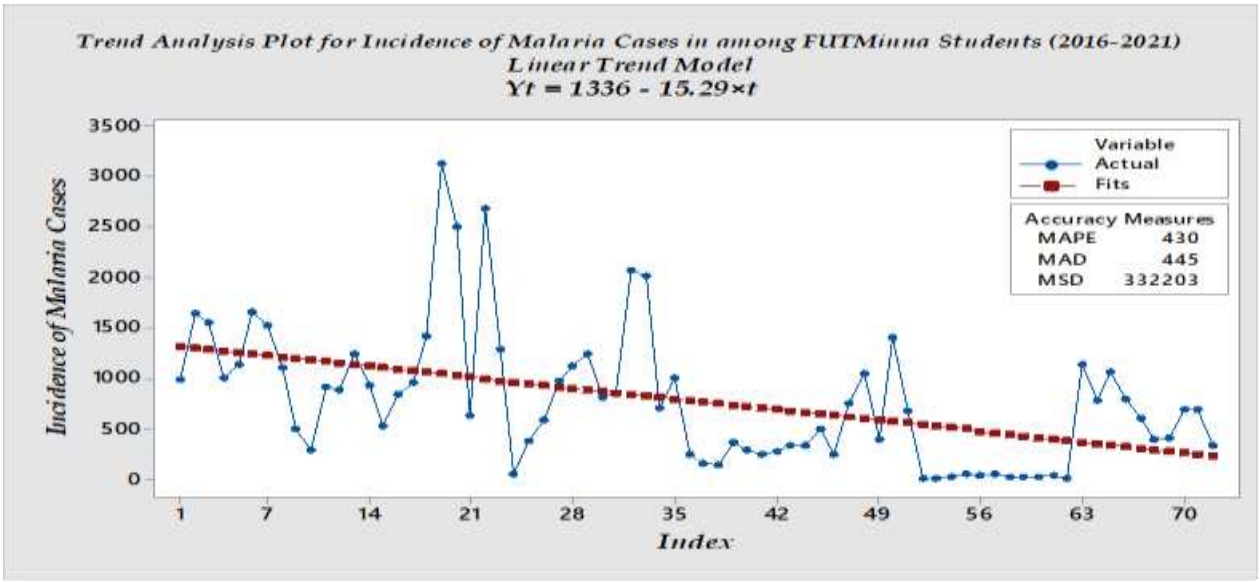

Figure 2: Trend Analysis Plot of the Incidence of Malaria Cases in FUT Minna.

This model (figure 2) depicts a progressive seasonal drop in the incidence rate of malaria cases among FUT Minna students and staff in relation to Time, demonstrating that any change in time would result in a 15-patient decrease in malaria cases. As a result, the number of malaria cases decreases by 15 patients every year. If the time factor is ignored, the malaria incidence would be 1336 cases.

Pearson correlation coefficient PPMCC (Test for studying the degree of relationship between variables)

Table 1: Pearson correlation coefficient between the incidence of malaria and rainfall

Correlations

		Incidence of Malaria	Rainfall
Incidence of Malaria	Pearson Correlation	1	.850
	Sig. (2-tailed)		.007
	N	72	72
Rainfall	Pearson Correlation	.850	1
	Sig. (2-tailed)	.007	
	N	72	72

According to the research's findings (table 1), rainfall and the frequency of malaria cases in FUT Minna are strongly positively correlated (Pearson Correlation (r) = 0.850). The statistical analysis showed that the sig. value (0.007) is lower than the level of significance (0.05), which suggested that rainfall has a substantial impact on the number of malaria cases reported at any particular time at FUT Minna clinics. This finding is in line with earlier findings from related research by Omonijo et al. (2011) and Siraj et al. (2014), which noted that mosquitoes depend heavily on water availability throughout their early stages of development. Although, Akinbobola and Omotosho (2013) noted that excessive precipitation can result in a decrease in the number of mosquito eggs and larvae at the breeding site, impeding mosquito survival and dispersal as well as development.

Table 2: Pearson correlation coefficient between the incidence of malaria and temperature

Correlations

		Incidence of Malaria	Temperature
Incidence of Malaria	Pearson Correlation	1	.105
	Sig. (2-tailed)		.001
	N	72	72
Temperature	Pearson Correlation	.105	1
	Sig. (2-tailed)	.001	
	N	72	72

Additionally, a weakly positive correlation between the fluctuating incidence of malaria and ambient temperature in FUT Minna is shown by the Pearson Correlation finding of temperature on malaria occurrence, (r) = 0.105. Since the sig. value (0.001) is smaller than the level of significance (0.05) in the significance test, it may be concluded that the air temperature significantly affects the pattern of malaria cases reported in FUT Minna clinics. Also, Segun et al.'s (2020) research showed that there is a corresponding decrease in malaria incidents of about 5.8% per month for every unit increase in atmospheric temperature, and that temperature above 240C, particularly during the dry season, is the threshold which prevents the breeding of the vector and reduces disease transmission. The dry season's reported decline in the research area's dry season may be caused by this.

Table 3: Pearson correlation coefficient between incidence of malaria and relative humidity

Correlations

		Incidence of Malaria	Relative Humidity
Incidence of Malaria	Pearson Correlation	1	.072
	Sig. (2-tailed)		.041
	N	72	72
Relative Humidity	Pearson Correlation	.072	1
	Sig. (2-tailed)	.041	
	N	72	72

According to the Pearson Correlation (r) value of 0.072, there is only a very slight correlation between malaria cases in FUT Minna and the percentage of relative humidity. The test of significance found that the sig. value (0.041) is less than the level of significance (0.05), which suggests that the amount of water in the air relative to the maximum amount it could hold at a given temperature has a significant impact on the cases of malaria incidents recorded in FUT Minna Clinics.

CONCLUSION AND RECOMMENDATION

Despite the fact that the World Health Organisation and the World Meteorological Organisation have designated malaria as one of the most climate-sensitive diseases and that there is a wealth of evidence linking malaria to changes in temperature, rainfall, and humidity (Fact sheet on malaria and the SDGs, 2015), the findings of this study showed that there is a stronger correlation between rainfall and the incidence of malaria in the Federal Universi Although changing humidity and rising temperatures can expand the area and severity of malaria transmission, their impact is minimal. Other factors influencing malaria occurrence include the amount of environmental sanitation, socioeconomic development, land use change, and disease control methods.

Overall, it is obvious that climate change has the potential to make the malaria burden at the Federal University of Technology worse, especially since the health services might not be ready to handle an increase in malaria cases. Effective solutions to this issue will need to be implemented in a coordinated manner that addresses not just the underlying environmental reasons but also the social and economic elements that contribute to the spread of malaria.

In the end, the scientific community, state and national governments will need to make a continuous commitment to the task of mitigating the effects of climate change on malaria. Because climate change is a worldwide issue that no one country can handle on its own, minimising its effects on anopheles mosquito reproduction and spread and ensuring effective care for malaria patients are of utmost importance. This study had demonstrated that throughout June, July, and August, there is an overall rise in the number of malaria patients. It is preferable that public awareness programmes be carried out in the months preceding that period to educate students on how to appropriately protect themselves from the anopheles mosquitoes responsible for

transmitting malaria. According to the findings, rainfall is an important component of climate that promotes mosquito reproduction and distribution; thus, indoor and outdoor fumigation of the institution with an environmentally friendly insecticide spray should be performed at the start of the rainy season to reduce and possibly eliminate mosquito breeding sites. Similarly, increased funding for the clinic and general student cooperation with school authorities on environmental sanitation and hygiene will protect the health and well-being of the student population while mitigating the negative effects of climate variability on malaria.

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