Comparative Analysis of Malaria Cases Using Geospatial-statistical Approach in Hadejia Metropolis, Jigawa State, Nigeria

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Abstract. Malaria is a significant public health issue in Nigeria where it accounts for more infections and deaths than any other nation in the world. Malaria is a concern for 97 percent of Nigeria’s population. The remaining 3 percent of the people reside in the malaria free highlands. There are an estimated 100 million malaria cases with over 300,000 deaths per year in Nigeria. It contrasts with 215,000 deaths a year in Nigeria from HIV / AIDS. Malaria contributes to an estimated 11 percent of maternal mortality. The study employed interpolated approach for the assessment and mapping of malaria cases from 2014 to 2018 in Hadejia metropolis and compares five year data of malaria prevalence within the political wards in the study area, using geo-spatial tools. The results showed that certain wards in the city have malaria cases danger which have a direct impact on human safety, social welfare which economy. The prevalence of the malaria parasites primarily exists in north and east of the sample country. Consequently the district is divided into eleven strata (political wards) which demonstrate that the higher incidence of Malaria for both years around Kasuwar Kofa, Kasuwar Kuda, Dubantu, Yayari and some portion of Matsaro and Gagulmari.

1. Introduction
Malaria is a severe viral disorder that has been the number one public health issue in the developing world [1], [2]. Malaria has been with man from ancient time to the modern civilization [3, 4]. The malignant and intermitted fever reported in ancient time in china, India, Mesopotamia Greece and Rome most definitely the same disease symptoms as found in our time [4–7]. Malaria is characterized as an acute infectious disease by plasmodium species and transmitted by mosquitoes of the genus plasmodium [8, 9]. Similarly, described malaria as an acute and often chronic infection disease triggered by a protozoan parasite of the plasmodium species plasmodium malaria, plasmodium vivax, and plasmodium falciparum. Malaria is the main cause of mortality in Nigeria, responsible since over five million case scenarios and thousands of death yearly. Malaria is a disorder that is spread from person to person by contaminated mosquitoes. Malaria may be deadly. The World Health Organization (WHO) estimate that 438,000 people...
died because of malaria in 2015, the institute of health metrics and evaluation (IHME) global Burden of disease (GBD) places this number as 720,000. Many perpetrators are adolescents. 72 percent of malaria deaths are infants less than 5 years old [8, 10]. It is one of the main causes of child mortality [4]. every tenth infant who died in 2016 died because of malaria [11]. Malaria is a major public health concern in Nigeria with over 100 million surgical cases and nearly one million deaths occurring annually [12]. However, the risks of morbidity and mortality associated with malaria, particularly in semi-arid and region vary spatially and temporally. In semi-arid and highland areas of Nigeria, malaria is unpredictable and epidemic malaria is a widespread concern, causing an approximate 12.74 million clinical incidents deaths annually [5]. However the extent of malaria vulnerability and transmission rate exhibit substantial spatial and temporal heterogeneity due to variance in location, altitude, topography and distribution of human settlement pattern [13]. The world health organization (WHO, 2005) stated that malaria influences the social and economic wellbeing of societies in affected areas draining scarce health and human resources interfering with educational achievement and causing persistent economic disadvantage. The degree of malaria burden does not only extend beyond immediate threats to survival. Malaria is an environmental disease approximately 70 to 90% risk of malaria in considered as a result of environmental factors influencing the abundance and survive of vectors [14–17].

2. Materials and Method

2.1 Study Area

Hadejia is a Hausa town in eastern Jigawa province, northern Nigeria. The population was approximately 105,628 in 2006, Wikipedia (2017) the inhabitants of Hadejia are predominantly Muslim, while some adopt indigenous belief system. Kanuri are mostly located in Hadejia emirate, with some traces of badawa mostly in eastern parts. However though each of the three powerful groups have continued to retain its Ethnic define Islam and a long tradition of Inter-marriage have continued to tie them together. Hadejia was once identified as Brian, and is referred to as one of the "seven real Hausa state" (Hausa bakwai).

![Figure 1](Image)  
**Figure 1.** Location of the study area.
2.2 Methodology

![Research workflow.](image)

3. Results and Discussions

The numerical total cases recorded from malaria patients are utilized to map the spatial distribution of all selected years (2014 to 2018). Table 1 below showed the malaria cases recorded by all health centers in the study. Among the health centers Hadejia general hospital, Agumo Primary Health Center (PHC), Kofar Arewa, Maternity and Gawuna Primary Health Center has the highest record of malaria cases. However, Arewa Clinic and Barga Clinic indicate low/less malaria cases due to poor health recording system and failure to submit appropriate records at PHC centers.

| S/n | Names                                      | 2014 | 2015 | 2016 | 2017 | 2018 |
|-----|--------------------------------------------|------|------|------|------|------|
| 1   | Agumo Primary Health Centre                | 2917 | 1058 | 1730 | 3744 | 5344 |
| 2   | Aguyaka Gudichin Basic Health Clinic       | 53   | 61   | 330  | 798  | 401  |
| 3   | Arewa Clinic                               | 1    | 0    | 0    | 0    | 0    |
| 4   | Baderin Gabas Primary Health Centre        | 0    | 0    | 0    | 940  |
| 5   | Barga Clinic                               | 0    | 41   | 0    | 63   |
| 6   | Dala Health Post                           | 749  | 0    | 0    | 160  | 659  |
| 7   | Fantai Basic Health Clinic                 | 749  | 0    | 0    | 160  | 659  |
| 8   | Gabari Primary Health Centre               | 60   | 152  | 245  | 115  | 491  |
| 9   | Gabari Primary Health Centre 1             | 850  | 5    | 233  | 559  | 900  |
| 10  | Gawuna Primary Health Centre               | 1466 | 1626 | 1824 | 3458 | 5798 |
| 11  | Hadejia General Hospital                   | 7854 | 1313 | 4005 | 6794 | 8097 |
| 12  | Hadejia TBL Hospital                       | 13   | 34   | 17   | 24   | 2    |
| 13  | Kofar Arewa Maternal Clinic (Hadeja)       | 2697 | 1407 | 1492 | 2221 | 5600 |
| 14  | Hadejia Police Clinic                      | 3    | 375  | 174  | 102  | 240  |
3.1 Statistical Analysis of the Malaria Incidents

Ho: There is no significant difference of malaria categories among the primary healthcare for the years under study (Table 2).
Ha: There is significant difference of malaria categories among the primary healthcare for the years under study (Table 3).

Table 2. One-sample statistics of malaria categories among the primary healthcare for the years under study.

| Year | N  | Mean | Std. Deviation | Std. Error | Mean |
|------|----|------|----------------|------------|------|
| 2014 | 41 | 406.41 | 886.085 | 138.383 |      |
| 2015 | 40 | 151.80 | 320.326 | 50.648 |      |
| 2016 | 36 | 279.17 | 510.760 | 85.127 |      |
| 2017 | 40 | 449.38 | 921.298 | 145.670 |      |
| 2018 | 48 | 594.48 | 1253.832 | 180.975 |      |

Table 3. One-sample test of malaria categories among the primary healthcare for the years under study.

| Year | t   | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference |
|------|-----|----|-----------------|-----------------|----------------------------------------|
|      |     |    |                 |                 | Lower | Upper |
| 2014 | 2.937 | 40 | .005           | 406.415         | 126.73 | 686.10 |
| 2015 | 2.997 | 39 | .005           | 151.800         | 49.35 | 254.25 |
| 2016 | 3.279 | 35 | .002           | 279.167         | 106.35 | 451.98 |
| 2017 | 3.085 | 39 | .004           | 449.375         | 154.73 | 744.02 |
| 2018 | 3.285 | 47 | .002           | 594.479         | 230.40 | 958.55 |

Statistics is one of the based way to understand and analyzed malaria incidences [1]. As indicated from above table1, the mean of the year of 2014, 2015, 2016, 2017 and 2018 are 406.41, 151.80, 279.17, 449.38, and 594.48, whereas the standard deviation 886.085, 320.326, 510.760, 921.298 and 1253.832. However in table 2, since the p-value less than alpha (0.025), we reject Ho and conclude that there is significant difference of malaria categories among the primary healthcare for the years under study.

Figure 3. Differences in the Mean.
Figure 4 below indicates the five years malaria incidences recorded in health centers in the study area. It also shows that 2018 has the highest record of malaria incidences due to the awareness of the advantages of visiting the health care centers when there is any kind of illness.

![Five Years Malaria Incidents in Hadejia Health Centers](image)

**Figure 4.** Yearly malaria incidence of different health center in study area.

Figure 5 below shows the geo-spatial pattern of malaria cases in Hadejia incidences recorded in 2014. Matsaro, Dubantu, Kasuwar kofa, Kasuwar kuda, Yayari, Majema, Rumfa, and Gagulmari recorded the highest malaria cases. In 2015 areas with high incidences of malaria include Dubantu, Yayari, Kasuwar Kuda, Matsaro, Kasuwar Kofa and Gagulmari.

![Spatial Distribution of 2014 Malaria Incidence in Hadejia](image)

**Figure 5.** 2014/2015 Geo-spatial pattern of malaria cases in Hadejia.
Figure 6. 2016/2017 Geo-spatial pattern of malaria cases in Hadejia

Figure 6 above shows the geo-spatial pattern of malaria cases incident recorded in 2016 and 2017. Yayari, Kasuwar kuda, Dubantu, Matsaro and Gagulmari wards recorded the highest malaria case in the year 2016. While in 2017 there was slight difference in the spatial pattern of malaria prevalence where by Kasuwar kuda, Yayari, Dubantu, Matsaro, Majema, Rumfa, Gagulmari, Kasuwar kofa wards were the highest in malaria prevalence.

Figure 7. Geo-spatial pattern of malaria cases in Hadejia, 2018
Figure 8. Five years level of malaria cases in Hadejia.

Figure 8 above shows the geo-spatial pattern of malaria incidence recorded in 2018, Kasuwar kofa, Dubantu, Yayari and Gagulmari wards records the highest malaria cases.

Figure 9. Geo-spatial pattern of health centers in Hadejia.
The spatial distribution of health care facilities is evenly distributed in the study area. Whereby individuals have access to health care facilities, the area is well-equipped with health facilities to curb the menace of malaria and other related illnesses in the area[1], Figure 5.

4. Conclusion
In Hadejia metropolis, there is wide prevalence of malaria parasites. A significant increase in malaria cases has been recorded between 2014-2018, conflicting environmental factors such as climate change which positively changes the ecology, habitat, and breeding grounds of the vector, the geographical location of the area as well as the poorly coordinated settlement pattern and environmental sanitation amount to the increase in malaria cases in the study area.

5. Recommendations
- Introduction of weekly (weekends) environmental sanitation at household level
- Flitting drainage and waterways with recommended insecticides to destroy mosquitoes and larvae at regular intervals to avoid air pollution
- Sensitization on the importance of environmental sanitation and waste disposal to eradicate the breeding ground of the vector
- People should be sleeping under mosquito nets as recommended by WHO.

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