Original Paper   http://ajol.info/index.php/ijbcs   http://indexmedicus.afro.who.int

Indicators and vectors related to malaria transmission in the Kozah and Doufel gou (Kara region, North Togo)

Yawo Eli KOUDAYA, Koffi Mensah AHADJI-DABLA[*], Edoh KOFFI,
Pirénam Pédro TATAH and Guillaume Koffivi KETOH

*Laboratoire d'Ecologie et d'Ecotoxicologie, Département de Zoologie, Faculté des Sciences,
Université de Lomé 1BP: 1515 Lome1, Togo.*
[*] *Corresponding author; E-mail: km.ahadjidabla@gmail.com*

ABSTRACT

Malaria is a vector-borne disease transmitted by Anopheles mosquitoes, in particular *Anopheles gambiae s.l.* To identify malaria vectors and establish a link between the presence of malaria vectors and malaria prevalence, a study was carried out in 7 localities of the Kara region: Lassa-Bas, Sarakawa, and Kpindi in the Kozah prefecture and Siou, Défalé, Ténéga and Broukou in the Doufelgou prefecture. Two malaria indicators were evaluated including the prevalence rate as well as consultation rate among children aged under 5 and pregnant women in the above-mentioned areas. Additionally, adult mosquitoes were collected using Human Landing Catch and Spray Catch techniques in the following localities: Lassa-Bas, Sarakawa, Siou, and Ténéga. Malaria prevalence rate was globally > 70%, the consultation rate was also > 50% among children under 5 years in the two prefectures. In pregnant women, the prevalence was > 60% while the consultation rate was 45%. A total of 592 mosquitoes were collected, divided into 3 genera: *Anopheles*, 521 (88%); *Culex*, 54 (9%); and *Aedes*, 17 (3%). Of the overall *Anopheles* mosquitoes collected, *Anopheles gambiae s.l.* represented 100% in all the localities (Lassa-Bas, 140; Sarakawa, 62; Ténéga, 303; and Siou, 16), followed by *Aedes aegypti*, *Aedes sp*, and *Culex spp*. The high rate of malaria prevalence could be potentially linked to the abundance of Anopheles mosquitoes.
© 2022 International Formulae Group. All rights reserved.

Keywords: *Anopheles gambiae*, malaria prevalence, consultation, Kara Region, Togo.

INTRODUCTION

Malaria is a potentially fatal endemic vector-borne disease caused by parasites transmitted to humans through the bite of infected female mosquitoes of the genus *Anopheles*. In 2019, there were an estimated 229 million cases of malaria worldwide; the estimated number of deaths attributable to malaria was 409,000 (WHO, 2020). Children aged under 5 (< 5 years) and pregnant women (PW) remain the most affected. Every 2 minutes, a child dies from malaria in the world, and without any significant progress and more funding to fight the disease, experts fear that this mortality rate may increase (Al Nowais, 2017). In sub-Saharan Africa, the disease severity and the highest mortality rates are recorded among < 5 years (20% of deaths) (Lakouéténé et al., 2009). In this region, malaria is the leading cause of medical

consultations, especially for children (Munier et al., 2009). Malaria is transmitted by more than 70 species of mosquitoes of the genus *Anopheles*. About 30 species belonging to this genus are described in sub-Saharan Africa (Sinka et al., 2012). Transmission intensity of *Plasmodium spp*. is very high in sub-Saharan Africa due to the main local vector species: *Anopheles gambiae s.s.*, *An. coluzzii*, *An. arabiensis*, and *An. funestus* (Mouchet et al., 2004; Coetzee et al., 2013).

In Togo, malaria is endemic, with transmissions occurring almost all year-round across the country. Pregnant women, unborn babies and < 5 years are at higher risk of suffering the harmful effects of malaria. Children < 5 years are prone to severe malaria infection due to lack of acquired immunity (PNLP, 2018). In 2019, hospital morbidity was 202.5‰. Children < 5 years continue to be the main victims and accounted for more than 50% of hospitalizations (PNLP, 2017) and almost half of deaths (47%) in this group are due to malaria (PNLP, 2015). Thus in 2019, Togo recorded 2,406,091 cases of both simple and severe malaria (PNLP, 2019). Moreover, malaria is a huge burden for communities due to the considerable weight it represents for the economy of Togo, especially for families with no substantial financial means. Malaria vectors have been extensively studied in various parts of the country, notably the maritime and the plateau regions. To date, there is no adequate information on malaria vectors in the Kara region. This study was conducted to determine the anopheline density in 4 localities, to collate them with malaria indicators, and then to identify the Anopheles mosquitoes in Kara, a region located northern Togo.

MATERIALS AND METHODS
Study area

The study was conducted in the Kara region (Figure 1). This region lies between 9°25' and 10°10' north latitude and 0°15' and 1°30' east longitude. The area enjoys a Sudanese Tropical climate with a dry season (November - March) and a rainy season (April-October). Annual rainfall is 1,200-1,400 mm. Average annual temperatures are around 27°C

and the average monthly temperatures vary between 25 and 30°C. The hydrographic network is represented by the Kara River in the south and the Kéran River in the north and partly, the Oti River basin with an irregular regime.

Mosquito collection

Mosquitoes were collected from 21-27 July 2020 in the localities of Siou (9°47'20"N-1°12'7"E) and Ténéga (9°48'39"N-1°8'6"E) in the Doufelgou prefecture. For the Kozah prefecture, it was done in Lassa-Bas (9°35'34"N-1°14'11"E) and Sarakawa (9°37'32"N-0°59'7"E) centers (Figure 1). Two methods were used: Spray Catch (SC) following the WHO trainee guide (OMS, 1994) and Human Landing Catch (HLC).

The SC technique is the collection of the morning residual mosquito's fauna between 5- and 6-hours using pyrethrum insecticide. Resting endophilic mosquitoes were knocked down or killed and collected on white sheets spread on the floor. To proceed, the door, windows, and any openings were sealed to hinder mosquitoes to escape from the room. Mosquitoes were collected 10 minutes after spraying the room the sheets, starting systematically from the front door.

Concerning the HLC technique, volunteers were sitting in the houses and/or rooms and proceeded with the collection of mosquitoes using a torch, a hemolysis tube, and a bag. For a better collection of the mosquitoes, volunteers adjusted their clothing up to their knees to expose their legs. When they felt a mosquito land on their body, they quickly turned on the torch, caught the mosquito with the hemolysis tube and plug it with a piece of cotton-wool. The collection lasted from 9 pm to 3 am.

Ethical considerations

The study was approved by the National Malaria Control Program of the Ministry of Health, Public Hygiene and Universal Access to Health Care of Togo. Informed consent was obtained from volunteers who participated in adult mosquito collection.

Retrospective data collection

Retrospective data of 2015-2019 was collected in the following health facilities: Kpindi, Sarakawa, Lassa-Bas, Siou, Défalé, and Broukou from. Data on the total number of positive RDTs, total RDTs used per year, the number of people who consulted for malaria, and the number of < 5 years who were consulted for any other condition as well as PW were collected.

Data processing and analyses

Statistical processing and analyses of the data were performed using Past version 3.23 software. Malaria prevalence was compared by year and by locality using a 2-criteria ANOVA without replication. The same test was applied for consultation rates under the same conditions. The number of mosquitoes captured per locality was compared using one-way ANOVA and then the number of anopheles captured in each locality by the Chi-2 test with a significance level of 5%.
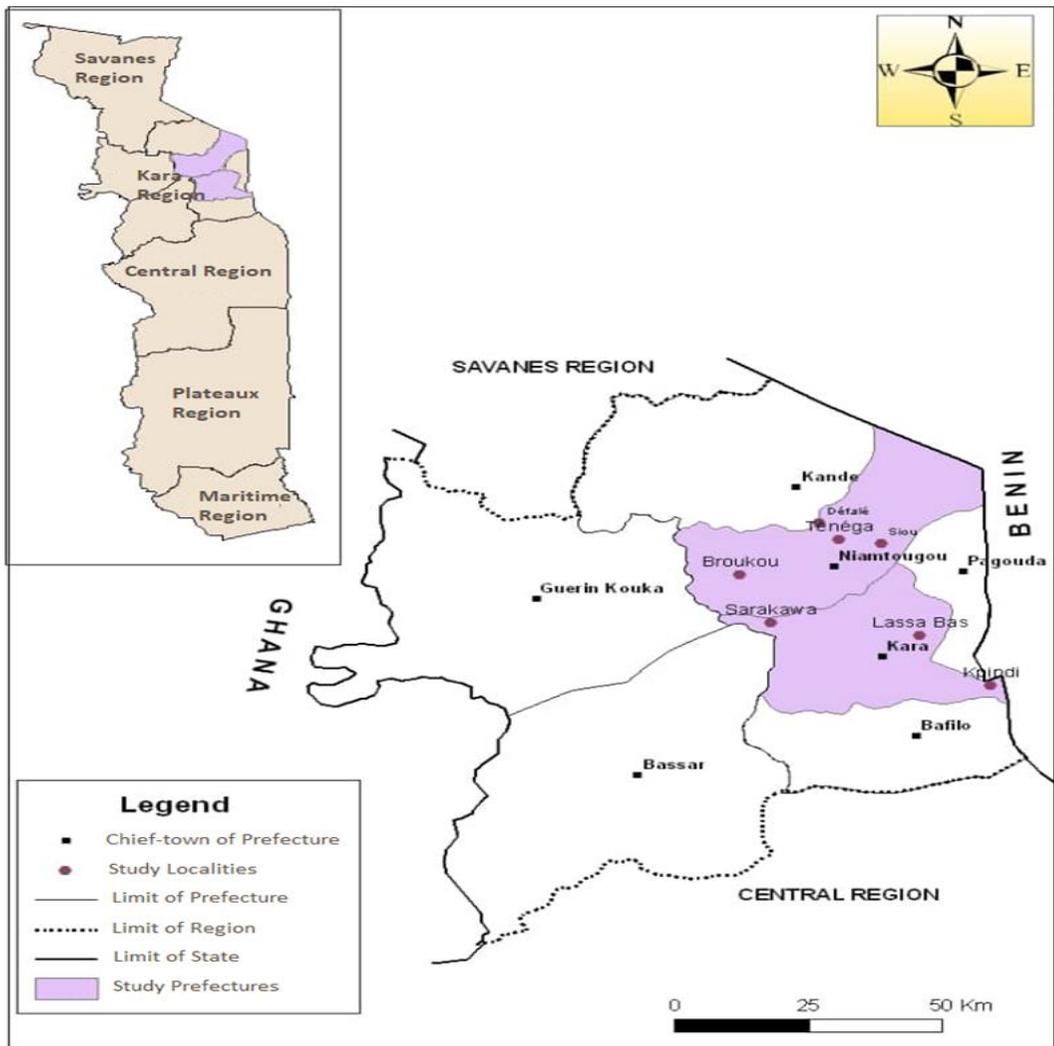
Figure 1: Map showing the study sites.

RESULTS

In Kozah, malaria prevalence in < 5 years was 80-90% from 2015 to 2019 at Kpindi; ~ 80% at Sarakawa and ~ 50% at Lassa-Bas (Figure 2). However, no significant difference was noted between years (p=0.82) and between localities (p=0.09). Consultation rates were also high (> 50%) in all localities and all years. Consultation was particularly high (> 80%) at Kpindi (Figure 3). The overall consultat ion and prevalence averages for 2015-2019 by location are shown in Table 1.

In PW, malaria prevalence was > 55% in all localities and through years but dropped to ~ 40% in 2018 in Kozah (Figure 4). In the same prefecture, consultation was 45-75% through the years with no significant difference (Figure 5).

In < 5 years, malaria prevalence was 45-80% in Doufelgou (Figure 6) and consultation was 40-70% with no significant difference between localities (p=0.41) (Figure 7).

In PW, malaria prevalence was ~ 85% and ~ 70% in 2018 at Broukou and Siou, respectively. No significant difference was noted in all years and all localities (Figure 8). Still in PW, consultation rate was high (~ 80%) at Broukou whereas it was ~ 25% at Siou (Figure 9).

A total of 592 mosquitoes divided into 3 genera: *Anopheles*, 521; *Culex*, 54; and *Aedes*, 17 were collected using SC and HLC (Table 2). Statistical analysis showed that there was no difference in collection effort between locations (p=0.6681); however, a significant difference was observed between *Anopheles* collected in these locations (p=7.82^{-16}) (Table 3). The species identified include *An. gambiae s.l.*, *Ae. aegypti*, *Aedes sp*, and *Culex spp* (Table 3).
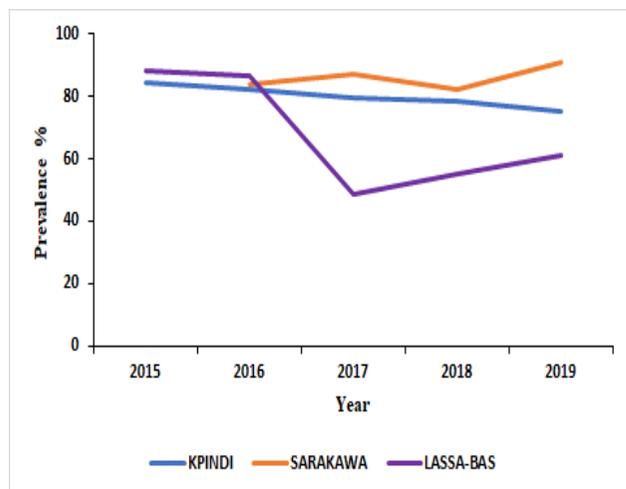
Figure 2: Variation of prevalence in < 5 years in Kozah.
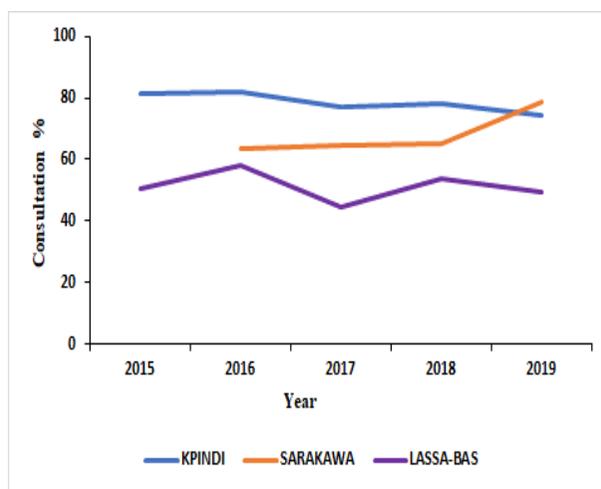
Figure 3: Variation of consultation rates < 5 years in Kozah.

Table 1: Average prevalence and consultation by location and target.

Localities	Prefecture	Prevalence (%)		Consultation (%)	
		0-59 months	Pregnant women	0-59 months	Pregnant women
Kpindi		80	70	78	65
Sarakawa	Kozah	86	79	68	69
Lassa-Bas		68	61	51	56
Siou		77	57	54	35
Défalé	Doufelgou	70	55	57	39
Broukou		70	72	52	60
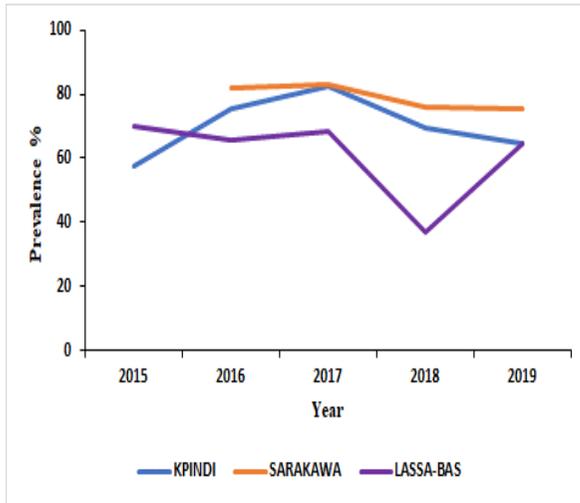
Figure 4: Variation of prevalence in PW in Kozah.
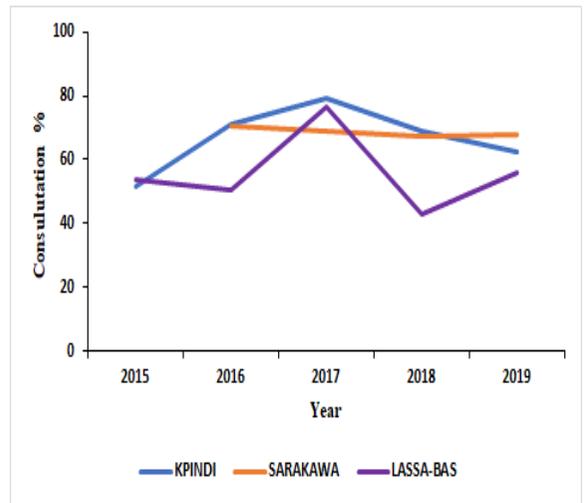
Figure 5: Variation of consultation rates in PW in Kozah.
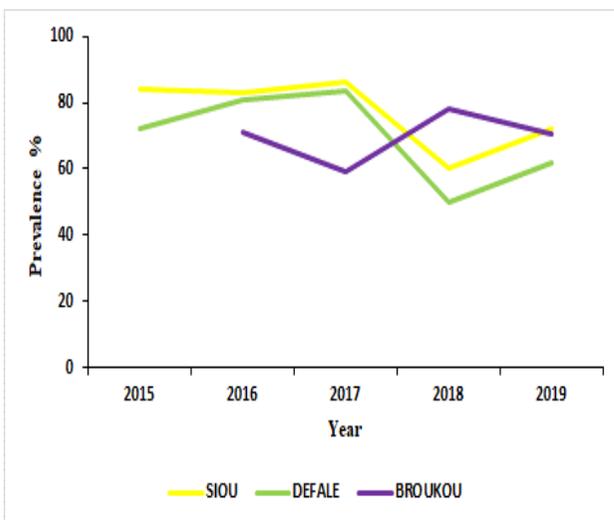
Figure 6: Variation of prevalence in < 5 years in Doufelgou.
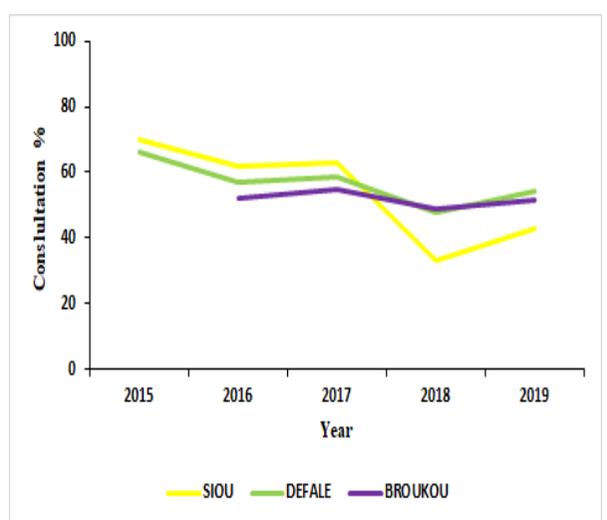
Figure 7: Variation of consultation rates in < 5 years in Doufelgou.
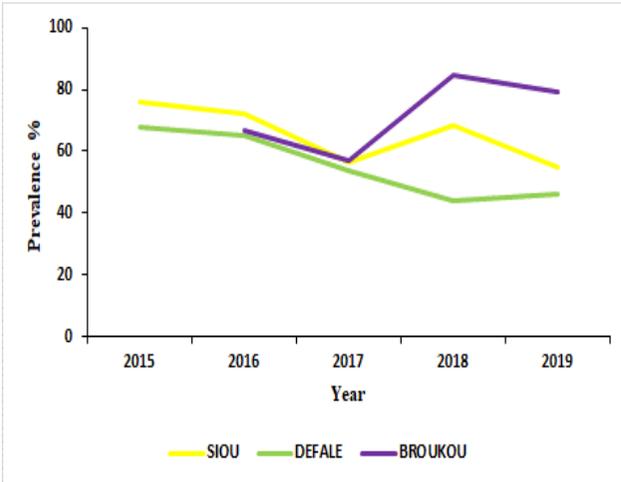
Figure 8: Variation of prevalence in PW in Doufelgou.
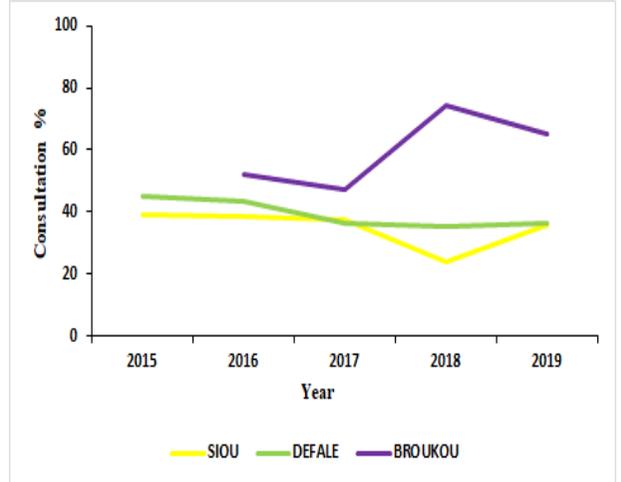
Figure 9: Variation of consultation rates in PW in Doufelgou.

Table 2: Density of the different genera of mosquitoes collected.

| Genera | Kozah | | | | Doufelgou | | | | |
| | Lassa-Bas | | Sarakawa | | Siou | | Ténéga | | |
	SC n (%)	HLC n (%)	SC n (%)	HLC n (%)	SC n (%)	HLC n (%)	SC n (%)	HLC n (%)	Total
Anopheles	109 (94)	31 (100)	56 (100)	6 (100)	16 (25)	0 (0)	268 (94,37)	35 (97,22)	521 (88)
Culex	7 (6)	0 (0)	0 (0)	0 (0)	46 (73)	0 (0)	1 (0,35)	0 (0)	54 (9)
Aedes	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	15 (5,28)	1 (2,78)	17 (3)
Total	116 (100)	31 (100)	56 (100)	6 (100)	63 (100)	0 (0)	284 (100)	36 (100)	592 (100)

Table 3: Specific abundance of the different mosquito species identified.

| Localities | Mosquito species | | | | |
	An. gambiae s.l. n (%)	*Ae. aegypti* n (%)	*Aedes sp* n (%)	*Culex spp* n (%)	Total
Lassa-Bas	140 (100)[a]	0 (0)[a]	0 (0)[a]	7 (100)[a]	147
Sarakawa	62 (100)[b]	0 (0)[a]	0 (0)[a]	0 (0)[b]	62
Siou	16 (100)[c]	1 (100)[b]	0 (0)[a]	46 (100)[c]	63
Ténéga	303 (100)[d]	15 (94)[c]	1 (6)[b]	1 (100)[d]	320
Total	521	16	1	54	592

Letters indicate significant difference of values in the same row.

DISCUSSION

At the end of this study, it was found that malaria prevalence and consultation rates are high in the two target groups (< 5 years and PW).

In the prefecture of Kozah, the prevalence of < 5 years was around 78% and the consultation rate was 66%, which could be explained by the malaria awareness activities carried out by community health workers (CHWs) in the field. Those activities are: educational communication, home visits, screening, and management of simple malaria cases in <5 years and timely referral of children aged 0 to 2 months who are more vulnerable. The case of Lassa-Bas seems to be an exception with more obvious decreases recorded from 2017 as compared to the other 2 localities of the prefecture. This could be explained by the chemoprevention of seasonal malaria (CSM) started in July 2016 in the entire region during a period of heavy rainfall and which probably had more impact in this locality due to its proximity to Kara, the regional capital city. In general, there was a non-significant decrease in malaria cases in <5 years during this period in regions that implemented CSM as compared to regions where CSM was not implemented (PNLP, 2016). In addition to the effect of the CSM, the situation at Lassa-Bas could also be attributed to the effective use of Long-Lasting Insecticide Net (LLIN) by the communities, given that the declines were recorded in 2017, a year of net distribution. The number of cases started increasing again in 2018 and even got worse in 2019. This could be explained by a decrease in the effectiveness of the nets overtime caused by the untimely washing of the LLINs with corrosive detergents, drying under the sun, and tearing. Studies in Uganda on the physical integrity of LLINs reported that 45-78% of nets were damaged after one year of use in operational conditions (Kilian et al., 2008). For PW in the same prefecture, the picture was similar.

In the Doufelgou health district, prevalence and consultations rates were above 50% with an average of 72 and 53%, respectively. These variations could also be

due to the decrease in the effectiveness of the nets over the years as reported by Egrot (2012). In addition, Kilian et al. (2010) reported that after a net distribution campaign, a decrease in the level of coverage is generally observed. In the first 2 years after the distribution, this decrease can reach 5 to 13% per year. In some cases, LLINs are used for other purposes (i.e. market gardening, fishing etc.) (Dhiman and Veer, 2014). Among PW, these rates were 61 and 45%, respectively, at district level. In terms of both prevalence and consultation rates, the locality of Broukou is above 70%. This could be explained by the predominance of Peuhl nomads in the locality and its surroundings who do not follow any protection measures against malaria mosquitoes. Also, a strong predominance of anopheline density in the study localities could explain the high prevalence. Permanent presence of puddles and farming around habitations constitute potential breeding sites and thus favorable conditions for the proliferation of mosquitoes.

Mosquito fauna in the localities was dominated by Anopheles (>90%). These results could be explained by the presence of numerous natural or artificial breeding sites (Carnevale et al., 2009) surrounding habitations. Ntonga et al. (2009) and Soma et al. (2018) reported Anopheles specific abundance of 67.86 and 93.07%, respectively. At Siou, 25% of Anopheles were collected due to the fact that we were not able to collect mosquitoes in the villages but rather inside the health center and surroundings. In fact, health workers who are most familiar with the conditions which favor mosquito proliferation always keep their environment clean. *Anopheles gambiae s.l.* represents 100% of the Anophelinae collected at Lassa-Bas, Sarakawa, Siou or Ténéga. This group, the best malaria vector (Djame et al., 2019), is highly anthropophilic, both endophage and exophage. Similar results were reported in other localities of the country such as Tchamba, Kolokopé, Kovié, and Lomé (Ahadji-Dabla, 2014, Ahadji-Dabla et al., 2014, Ahadji-Dabla et al., 2019).

Conclusion

Malaria prevalence and consultation rates were very high in the 6 localities of Kara region. The significant density of *Anopheles* reflects this prevalence rate. The predominance of Anopheles in these environments, with *Anopheles gambiae s.l.* being one of the main vectors in the Afrotropical zone, must be used to sensitize the local populations on the burden malaria represents for their communities.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

YEK, EK and PPT participated in data curation; YEK and EK analyzed the data; KMA-D and GKK supervised the work; YEK, KMA-D, PPT, and EK participated in the original drafting of the manuscript; and KMA-D and GKK reviewed and edited the final version of the manuscript.

ACKNOWLEDGEMENTS

REFERENCES

Ahadji-Dabla KM. 2014. Les vecteurs du paludisme au Togo: Distribution géographique des espèces, statuts de sensibilité aux insecticides et perspectives de lutte antivectorielle. Thèse de doctorat, Université de Lomé, Togo, p182.

Ahadji-Dabla KM, Ketoh GK, Nyamador WS, Apétogbo GY, Glitho IA. 2014. Susceptibility to DDT and pyrethroids, and detection of knockdown resistance mutation *in Anopheles gambiae sensu lato* in Southern Togo. *Int. J. Biol. Chem. Sci.*, **8**(1): 314-323. DOI: http://dx.doi.org/10.4314/ijbcs.v8i1.27

Ahadji-Dabla KM, Ngoagouni C, Dery BD, Apétogbo YG, Ketoh GK, Glitho IA. 2019. Spatio-seasonal distribution of *Anopheles gambiae sensu lato* and dynamics of the Voltage gate sodium channel knock down resistance mutation (Vgsc-1014F) in the city of Lomé, Togo. *Int. J. Biol. Chem. Sci.*, **13**(3): 1654-1668. DOI: https://dx.doi.org/10.4314/ijbcs.v13i3.36

Al Nowais S. 2017. Malaria kills a child every two minutes - and experts fear it'll worsen without more action. In: *The National.* https://www.thenational.ae/uae/malaria-kills-a-child-every-two-minutes-and-experts-fear-it-ll-worsen-without-more-action-1.676014 Consulté le 30 juillet 2020.

Carnevale P, Robert V, Manguin S, Corbel V, Fontenille D, Garros C, Roux J. 2009. *Les Anophèles: Biologie, Transmission du Plasmodium et Lutte antivectorielle*. IRD: Marseille ; 391p..

Coetzee M, Hunt RH, Wilkerson R, Della Torre A, Coulibaly MB, Besansky NJ. 2013. *Anopheles coluzzii* and *Anopheles amharicus*, new members of the *Anopheles gambiae* complex. *Zootaxa*, **3619**: 246–274. DOI: https://doi.org/10.11646/zootaxa.3619.3.2.

Dhiman S, Veer V. 2014. Culminating anti-malaria efforts at long lasting insecticidal net? *J Infect Public Health*, **7**: 457-464. DOI: https://doi.org/10.1016/j.jiph.2014.06.002

Djame Y, Alassane A, Boukpessi T, Lare YL. 2019. Nuisances culicidiennes, lutte antivectorielle et prévention du paludisme dans la région des savanes au nord-Togo. *Rev Géogr Univ Ouagadougou*, **3**(8): 209-230.

Egrot M. 2012. Anthropologie des objets de la lutte antivectorielle. Suds en ligne. Les dossiers thématiques de l'IRD: Vaincre le paludisme. IRD-02069795.

Kilian A, Byamukama W, Pigeon O, Atieli F, Duchon S, Phan C. 2008. Long-term field performance of a polyester-based long-lasting insecticidal mosquito net in rural Uganda. *Malar J*, **7**: 49. DOI: https://doi.org/10.1186/1475-2875-7-49.

Kilian A, Wijayanandana N, Ssekitoleeko J. 2010. Review of delivery strategies for insecticide treated mosquito nets – are we ready for the next phaseof malaria control efforts? *TropIKA*.net **1**: 1-28. http://journal.tropika.net.

Lakouéténé DPB, Ndolngar G, Berké B, Moyen J-M, Kosh Komba E, Zinga I, Silla S, Millogo-Rasolodimby J, Vincendeau P, Syssa-Magalé J-L, Nacoulma-Ouedraogo OG, Laganier R, Badoc A, Chèze C. 2009. Enquête ethnobotanique des plantes utilisées dans le traitement du paludisme à Bangui. *Bull Soc Pharm Bordeaux,* **148**: 123-138.

Mouchet J, Carnevale P, Coosemans M, Julvez J, Manguin S, Richard-Lenoble D, Sircoulon J. 2004. *Biodiversité du Paludisme dans le Monde*. Edition John Libbey Eurotext: Paris, France, 428 p.

Munier A, Diallo A, Sokhna C, Chippaux J. 2009. Evaluation d'un test de diagnostic rapide du paludisme dans les postes de santé ruraux au Sénégal. *Med Trop*, **69**: 496-500. DOI: https://doi.org/10.3185/pathexo3331.

Ntonga PA, Bakwo EM, Belong P, Kekeunou S, Foko G, Messi J. 2009. Abondance et diversité de la faune culicidienne à Yaoundé, Cameroun. *Entomol faun-Faun Entomol,* **62**: 115-124.

OMS. 1994. Tecniques Entomologiques Pratiques Pour La Lutte Antipaludique. Genève : Organisation mondiale de la Santé.

PNLP. 2015. Programme National de Lutte contre le Paludisme. Ministère de la Santé et de l'Hygiène Publique du Togo. Rapport annuel.

PNLP. 2016. Programme National de Lutte contre le Paludisme. Ministère de la Santé et de l'Hygiène Publique du Togo. Rapport annuel.

PNLP. 2017. Programme National de Lutte contre le Paludisme. Ministère de la Santé et de l'Hygiène Publique du Togo. Rapport annuel.

PNLP. 2018. Programme National de Lutte contre le Paludisme. Ministère de la Santé et de l'Hygiène Publique du Togo. Rapport annuel.

PNLP. 2019. Programme National de Lutte contre le Paludisme. Ministère de la Santé et de l'Hygiène Publique du Togo. Rapport annuel.

Sinka ME, Bangs MJ, Manguin S, Rubio-Palis Y, Chareonviriyaphap T, Coetzee M, Mbogo CM, Hemingway J, Patil AP, Temperley WH, Gething PW, Kabaria CW, Burkot TR, Harbach RE, Hay SI. 2012. A global map of dominant malaria vectors. *Parasit Vectors*, **5**: 1-11. DOI: 10.1186/1756-3305-5-69.

Soma DD, Namountougou M, Sangaré I, Sawadogo SP, Maiga H, Yaméogo B, Sanou R, Poda S, Fournet F, Tinto H, Diabaté A, Dabiré RK. 2018. Transmission entomologique du paludisme à Nanoro, site de l'essai vaccinal rts's au Burkina Faso. *Rev Cames Santé*, **5**: 15-20.

Toure DS, Ouattara AF, Kwadjo KE, Kouadio Dagobert K, Doumbia M, Doannio JMC. 2018. Diversité spécifique des anophèles et répartition saisonnière des vecteurs majeurs du paludisme de la savane sèche rurale du Nord de la Côte d'Ivoire. *Afrique Science*, **14**: 31-39. http://www.afriquescience.net.

WHO. 2020. World Malaria Report. World Health Organization, Geneva Swirtzerland, Licence: CC BY NC-SA 3.0 IGO.