Seasonal climate variability and their impact on malaria prevalence in the health zone of Katana (DR Congo) from 2004 to 2013

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ABSTRACT:

Seasonal climate variability is a reality in Eastern DR Congo. Malaria is also a serious public health and socio-economic problem in this country in general and in the Katana Health Zone in particular. A retrospective documentary study was carried out between the period 2004 and 2013. This work aims to determine the impact of seasonal climate variability on malaria prevalence; to determine the factors influencing the prevalence of malaria and the most vulnerable age group of this pathology in the Katana Health Zone. All cases of simple and severe malaria have been collected from Health Information System (SNIS) data base of all health facilities in the Health Zone for the last ten years. Climate data (temperature and rainfall) were collected at the climatological station of the Centre de Recherche en Sciences Naturelles (CRSN/Lwiro) for the same decade. The results of the study showed that the prevalence of malaria varies from year to year and evolved in serrated with a higher peak in 2005, slightly in 2006 during the last three years of the study. Children under 5 years of age and pregnant women are the most vulnerable age group of malaria in these health facilities. The population of the Katana Health Zone suffers from malaria in both seasons but much more during the rainy season. The relationship between malaria prevalence and precipitation is no significant ($p>0.05$), and is positively significant between malaria prevalence and temperature ($p<0.01$). The raison is discuss in this paper.

Key Words: Climatic variability, Malaria, Health Zone of Katana, DR Congo.

INTRODUCTION

Seasonal climate variability is pointed at a possible health disaster; the most common allegations are the assumed responsibility for climate variability in creating favorable conditions for malaria (Mohammed, 2013). Inter-annual and inter-decadal climate variability may have a direct influence on the epidemiology of vector-borne diseases (Githeko et al., 2000). Rainfall influences the availability and quality of breeding sites. In all regions of the world where there is a long dry season anopheles are very scarce (Ndiaya et al.,

2001). In these areas, the rate and extent of precipitation are key factors determining the existing vector species and their abundance and the duration of their seasonal presence (Ndiaya et al., 2001; Magne, 2012).

According to the report of the Intergovernmental Panel on Climate Change (IPCC) 2001 estimates that by 2050, the Sahara and the semi-arid regions of southern Africa could heat up to 1.6 °C, while Equatorial countries may experience a warming of 1.4 °C (Githeko et al., 2000; Ndiaya et al., 2001). Temperature and precipitation are favorable for malaria in some areas of Europe and Africa, a threat of malaria transmission (Hackett, 2006). In Africa, it was estimated 1.6 and 5.4 malaria affected children; 500,000 cases of cerebral malaria are reported each year and 7 % of those children who survive have disabilities for the rest of their lives (Unicef, 2004).

Pregnant women are not spared from this pathology; in Africa, between 75,000 and 200,000 children are born to pregnant women on malaria with low birth weight (Hiid, 2006). Malaria in pregnant women is a major cause of maternal anemia and a major risk of low birth weight childbirth (Steketee and Nahlen, 2001). Malaria and pregnancy are two situations that aggravate each other, because malaria is more serious and frequent during pregnancy, causing significant maternal, fetal and perinatal morbidity and mortality (Tako, 2005).

Despite the efforts made by DR Congo, the numbers of malaria cases continue to increase; the new climate and environmental conditions contribute to the re-emergence of the disease; the province of South Kivu is not spared from this endemic. With regard to climate change, one can easily imagine the impact of even a small increase in temperature associated with an increase in rainfall on the vector ecosystem. In the Katana Health Zone, the vulnerability of the disease in the population still represents a major health challenge where malaria is the leading cause of consultation and hospitalization.

Many efforts are being made at the Central Office of the Health Zone in the implementation of insecticide-treated mosquito net distribution, intermittent preventive treatment for pregnant women and awareness raising on environmental management (Report Central Health Zone office/ Katana, 2012), but no changes in the endemiciy of the diseases. This study aims to assess the extent of climate and seasonal variation in malaria in the Health Zone over the last decade to determine seasonal control strategies.

MATERIAL AND METHODS

Description of the study environment

Katana Health Zone is one of 34 Health Zones in South Kivu Province, and it is border with the Kalehe Health Zone, Miti-Murhesa and Bunyakira (Figure 1).

Figure 1. Map of the Health Zone of Katana

Health Zone of Katana is located about 52 Km North of the city of Bukavu, with an area of 400 Km^2 located between 028° 045' and 028° 85' E longitude; 02° 15' and 02° 30' S latitude (Bagalwa et al., 2014). It has 17 Health Center of which 2 are of reference Hospital Center (Ihimbi and Mugeri), and one General Hospital of Reference (HGR/FOMULAC). These health areas are: Ciranga, Katana/Nuru, Kabushwa, Kabamba, Kadjucu, Mabingu, Luhihi, Iko, Ibinja, Ishungu, Lugendo, Cishugi and Mushweshwe.

The Health Zone of Katana has a tropical climate, characterized by a heavy rainfall of over 1500 mm/year and a moderate temperature of 18° to 20°C. There are two seasons: a long rainy season from September to May and a short dry season from June to August. Its vegetation is a cultivated savanna that has replaced the forest with original *Albizia grandibracteata*. The relief is varied by hills, valleys, plateaus as well as the forest overlooking the Kahuzi Biega National Park (PNKB), with an altitude of about 1500m and 2000m towards the Kahuzi Biega Park (Bagalwa et al., 2014). This Health Zone was chosen because of its geographical location, favoring various larval sites (marshes, rivers, fish ponds, etc.), thus creating favorable conditions for malaria.

Data collection method.

All cases of confirmed simple and severe malaria were collected in all health facilities via the Central Office of the Health Zone from January 2004 to December 2013. All of these cases constituted the exhaustive sample of the study. To achieve this, we used the National Health Information System (SNIS) fact sheets that contain all the information on malaria. In addition the climatological data (rainfall, monthly temperature) of January 2004 to December 2013 were taken from the meteorological station of the "Centre de Recherche en Sciences Naturelles de Lwiro" (CRSN/LWIRO).

Statistical analysis

During the analysis of the collected data, it was a question of synthesizing all the information by exploiting the indicated statistical methods: frequency, mean, standard deviation and we checked our hypothesis of research by the comparison of the averages by using the test t of independent sample. The data are presented as tables and graphs using the Excel software and comparing the meteorological parameters (temperature and rainfall) and prevalence of malaria in the Katana Health Zone by Person correlation analysis. The materiality threshold was fixed at $p < 0.05$.

RESULTS

Prevalence of malaria in the Katana Health Zone

The annual prevalence of malaria in the Katana Health Zone during the last 10 years of the study is shown in Figure 2 (Figure 2).

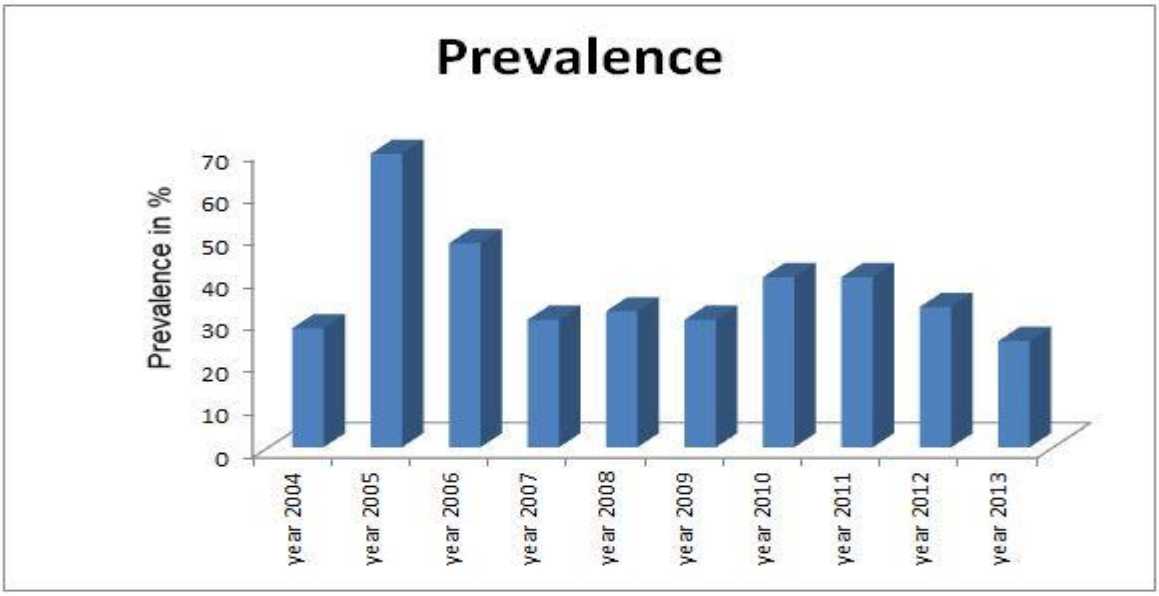

Figure 2. Prevalence of malaria in the Katana Health Zone during the last 10 years (2004 – 2013).

From this figure, it appears that the prevalence varies from one year to another. It was very high in 2005 and lower in 2004 and 2013. There is some consistency in other years with a slight increase in 2006, 2010 and 2011.

Identification of the most vulnerable group of malaria in the population of Katana Health Zone

Vulnerable group of malaria in the population of Katana Health Zone is present in Table 1.

Table 1. Positive case of malaria in most vulnerable group of population

	Dry season (%)	Rainy season (%)
Chlidren under 5 years	46	54
Pregnant women	44	56
All population	47	53

The table shows that the average percentage of children under 5 years old during the last ten years is reached over the rainy season with 54% than the dry season with 46%. The difference is not significant ($p > 0.05$) but the trend shows that the rainy season has more cases than the dry season. Pregnant women are also victims of malaria in the rainy season with 56% in the dry season with 44%. Population of the Katana Health Zone has suffered from malaria in different periods of the year with an average of 53% in the rainy season and 47% in the dry season. But the difference is not statistically significant ($p > 0.05$). For both vulnerable groups, the rainy season shows a high rate of malaria case as the dry season during the 2004-2013 period in the Katana Health Zone.
The average monthly change in positive malaria cases in the population of the Katana Health Zone over the past ten years is shown in Figure 3.

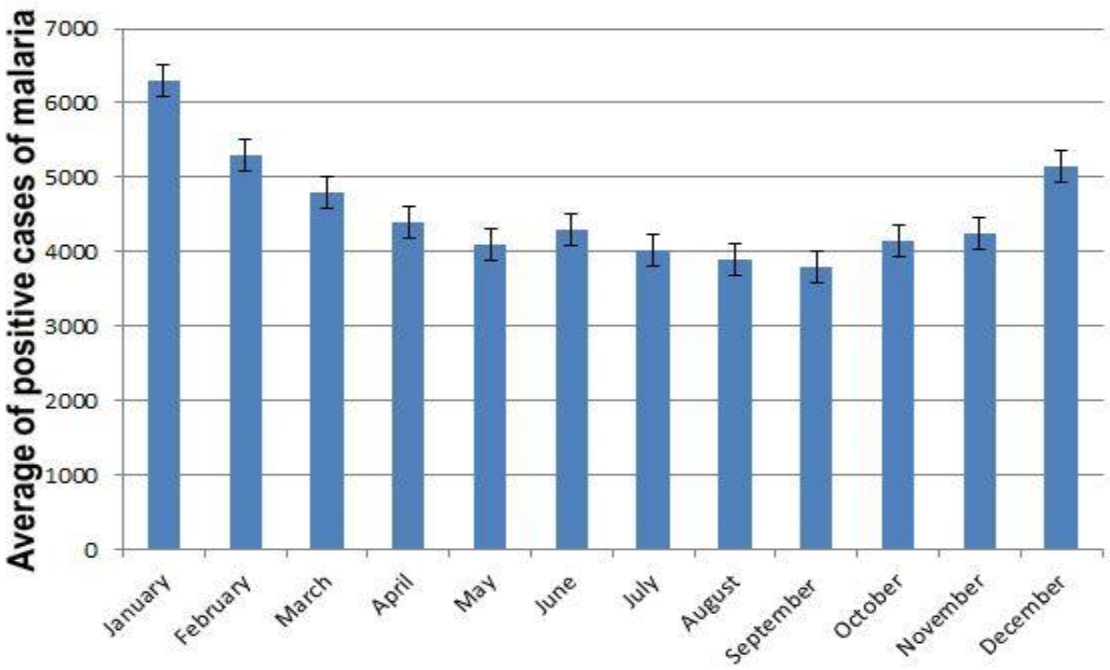

Figure 3. Monthly mean variation of positive cases of malaria (2004-2013)

This figure shows that during all the years cases of malaria are observed but the months of January to May and October to December the cases of malaria are higher than the month of June to August. It is during the rainy season that the rate of malaria is high.

Determination of the factors influencing the prevalence of malaria in the Katana Health Zone (precipitation, temperature).

The meteorological factors inferring the prevalence of malaria in the Health Zone of Katana evaluate in this work remains the rainfall and the drought. The monthly temperature change in the Katana Health Zone over the past 10 years is shown in Figure 4.

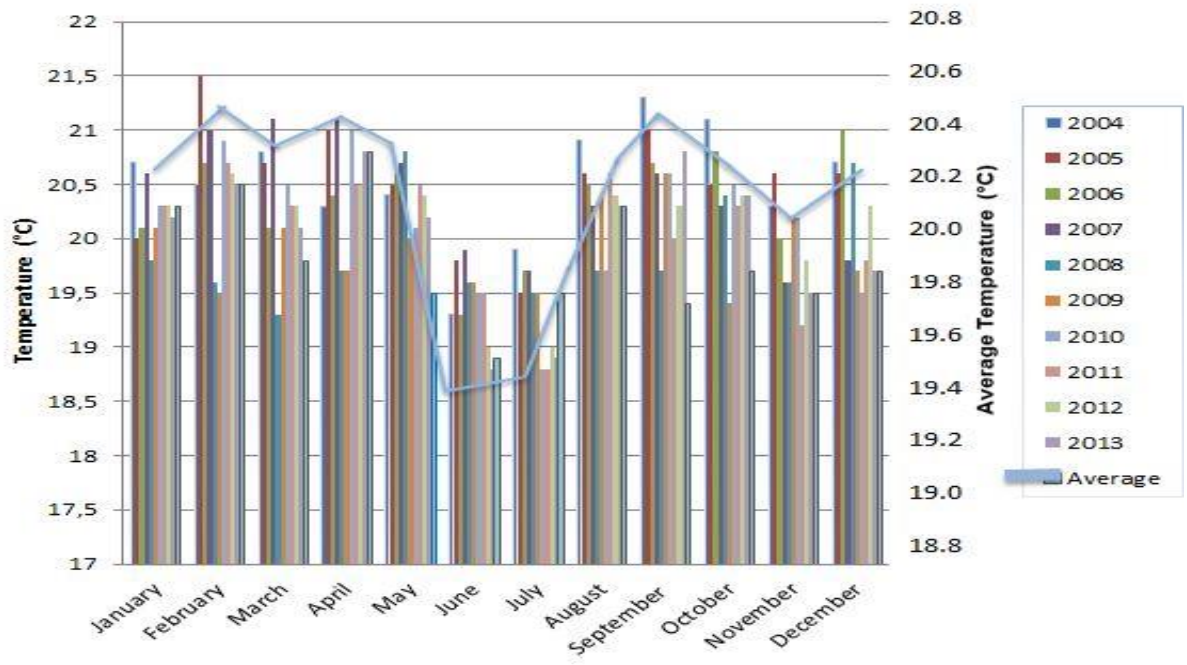

Figure 4. Temperature variation and monthly mean during 10 years.

This figure shows that the temperature in the Katana Health Zone fluctuates considerably from one year to the next. The temperature peaks are recorded in the rainy season. Low temperatures are recorded in the dry season.

As for precipitation in the Katana Health Zone, it also varies with the months of the year, the results are shown in Figure 5.

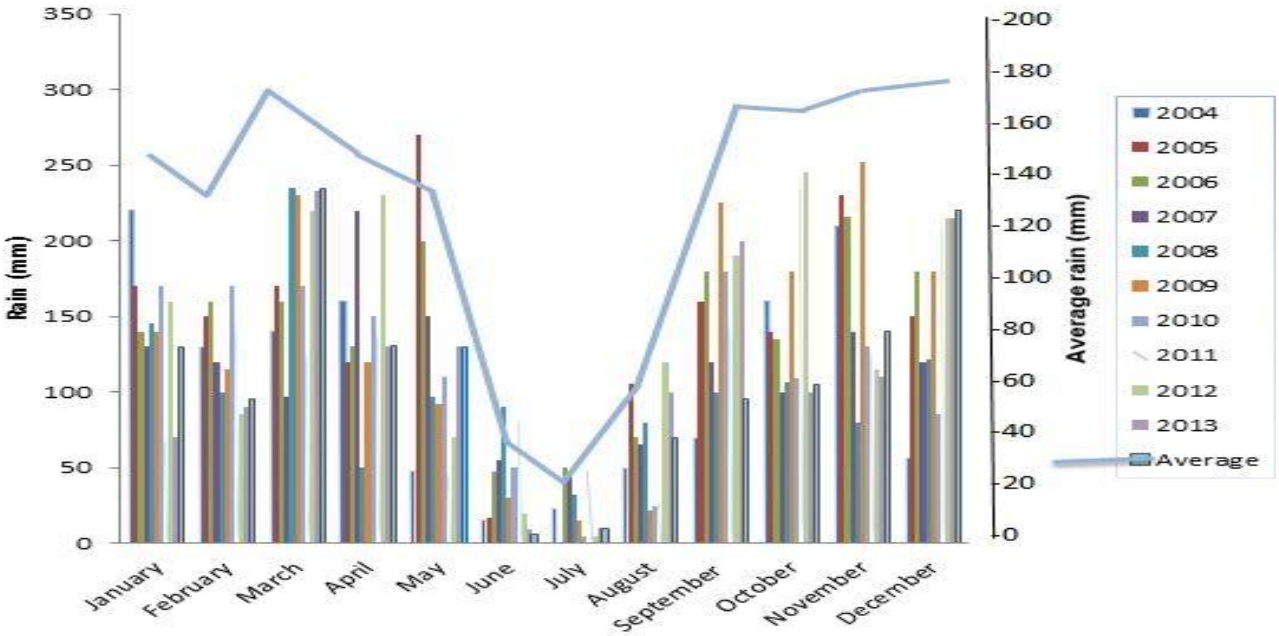

Figure 5. Precipitation variation and monthly mean during 10 years.

This figure 5 shows how rain varies by month in the Katana Health Zone during the last ten years. The same observations are also valid for the temperature. The months of June to August have a low rainfall compared to other months.

Determination of the relationship between malaria prevalence and rainfall

The relationship between the mean prevalence of malaria and the annual average rainfall in the Katana Health Zone during the last 10 year period of the year is shown in Figure 10 (Figure 10).
It appears from this figure that during the last ten years the increase in malaria cases is conditioned by rain, however they are also present in the dry season but in a small proportion. Person correlation between malaria prevalence, temperature, and rainfall in the Katana Health Zone during the study period is presented in Table 2.

Table 2. Person correlation between malaria, temperature and precipitation in the Health Zone of Katana during the years 2004-2013.

	Temperature	Precipitation	Malaria
Temperature	0		
Precipitation	-0.05	0	
Malaria	0.029	0.706	0

From table 2 it can be seen that in the Katana Health Zone the correlation is negative and significant between temperature and rainfall ($p = -0.05$). It is positive and significant between temperature and malaria ($p = 0.029$). But there is a non-significant positive correlation between malaria and precipitation ($p = 0.706$).

DISCUSSION

In the Katana Health Zone, the prevalence of malaria varies from year to year. It was very high in 2005, it has increased again in the last three years. This increase in the prevalence rate is probably due to the non-use of insecticide-treated mosquito nets as found by WHO / UNICEF, (2005). These results are also similar to those obtained by Rault and Martinez, (2011) on the prevalence of malaria in the Goa region in India. Pregnant women and children under 5 years were also victims of malaria as observed in the Katana Health Zone. High prevalence were recorded in the rainy season than in dry season. The number of positive cases of malaria was observed throughout the year with high prevalence in January to May and October to December. These results similar to those of the WHO report (2006) and Lukuku and Mulumbu (2006) in Kinshasa, which argues that the prevalence of malaria is high among pregnant women and children under 5 years old due to their high prevalence acquired immunity deficient in this period. The same situation has been observed in Uganda as shown by Mohammed (2013) and Gahouma and Kombila (1997) in his retrospective pediatric study of Owendo Hospital in Gabon. Another study by Tako (2005) in Cameroon confirms that malaria appears to be more common during pregnancy period. These results are similar to a descriptive surveys cited by Hommerich et al., (2007) in tropical Africa. These concordant studies demonstrate the consequences of the plasmodial infection during pregnancy.

Monthly temperature and precipitation variations are observed during the last ten years in the Katana Health Zone with low rainfall in June to August. In recent years, several studies confirm that the climate has changed dramatically on the globe as confirmed by Githeko et al., (2000) and that the temperature could increase to more than 1.6 °C during the 2050s and that in Africa the rains will be

abundant. Climatic variabilities are sources of variations of the prevalence rates of vector-borne diseases as the case in the Health Zone of Katana. Temperature and rainfall are favorable for malaria in some areas of Europe and Central Asia suggesting a threat of malaria transmission as reported by Hackett (2006). Confalonieri and Costa-Dias, (2000) also confirms that malaria has tended to return to endemic and epidemic levels in Brazil by the end of the year following El Niño.

Conclusion

This study determine the impact of seasonal climate variability on the prevalence of malaria in the Katana Health Zone during the last ten years of 2004-2013. Variation in the prevalence of malaria during this period of study reflects a reality and it's varied from year to year. Climate factors (rainfall and temperature) have varied also tremendously during the last ten years. Population of the Katana Health Zone in general has been a victim of malaria all the year, especially children under 5 years and pregnant women. This study has allowed us to better understand the correlation between climate, season and the prevalence of malaria in the environment. The rainy season is crucial period for the distribution of insecticide-treated mosquito nets to effectively prevent malaria in the population of the Katana Health Zone.

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REFERENCES

Bagalwa M., Chifundera K., Nkemba B., Mashali B., Ndahama N., Polepole N., 2014. Environnement et santé dans la Zone de Santé de Katana, Sud-Kivu, République Démocratique du Congo. Annales de l'Université Evangélique en Afrique, 35 – 47

Confalonieri U. E. C., Costa-Dias R., 2000. Climate variability, land use/ land cover change and malaria in the Amazon: Preliminary results from the State of Roraima, Brazil: Abstracts of the first LBA Scientific Conference, Belem; CPTEC/INPE, 17pp.

Gahouma D., Kombila M., 1997. Aspects du paludisme de l'enfant en milieu hospitalier gabonais. Médecine Trop., 57, 2, 177-180

GIEC, 2001. Bilan des Changements Climatiques : les Eléments Scientifiques. Groupe de travail I. Genève, Suisse, 184 p.

Githeko A. K., Lindsay S. W., Confalonieri U. E., Patz J. A., 2000. Changement climatique et maladies à transmission vectorielle : Une analyse régionale. Bulletin of the World Health Organization, 78, 9, 1136-1147

Hackett L., 2006. Malaria in Europe: An Ecological Approach. Oxford University Press, London; 1937p.

Hiid L., 2006. Le paludisme chez la femme enceinte. *Med. Trop.*, 66, 130 -132.

Hommerich L, von Oertzen C, Bedu-Addo G, Holmberg V, Acquah PA, Eggelte TA, Bienzle Ulrich, Mockenhaupt FP, 2007. Decline of placenta malaria in Southerm Ghana after the implementation of intermittent preventive treatment in pregnancy. Malaria Journal, 6,144. doi:10.1186/1475-2875-6-144.

Tako EA, 2005. Risk factors for plancetal malaria and its effect on pregnancy outcome in Yaounde, Cameroun. Am J Trop.Med.Hyg; 72, 236-242.

Lukuku K.A., Mulumbu M.R., 2006.Prévalence du paludisme à l'accouchement dans quatre maternités de la ville de Kinshasa, RDC. Bull. soc. Patho. Exoc., 99, 2839, 200-201.

Magne E. K., 2012. Paludisme et interprétations sociales du changement climatique à l'ouest du Cameroun. Territoire en mouvement Revue de géographie et aménagement, 14-15, 45-54. DOI:10.4000/tem.1726

Marrama L., Laventure S., 1995. Les gites larvaires d'*Anophèles funestus* sur les plateaux de Madagascar. Cahiers santé, 5, 415-419.

Mohammed S., 2013. Modelling of climate induced relative malaria incidence in the major sub climatic zones of Uganda. Master thesis, University of Makele, Ethiopia, p.56.

Ndiaye O, Le Hesran JY, Etard JF, Diallo A, Simondon A, Ward MN, Robert V, 2001. Variations climatiques et mortalité attribuée au paludisme dans la zone de Niakhar, Sénégal, de 1984 à 1996. Cahiers Santé, 11, 25-33

OMS/UNICEF, 2005. Le premier rapport mondial sur les efforts pour faire reculer le paludisme fait le point des progrès accomplis et des défis à relever, Genève/New York.

Rault J-B., Martinez V., 2011. Fièvre au retour d'un pays tropical. EMC (Elsevier Masson SAS, Paris), Traité de Médecine, Akos, 1-0600.

Steketee R. W., Nahlen B. L., 2001. The burden of malaria in pregnancy in malaria-endemic areas. Am J Trop. Med. Hyg.; 64, 1-2 suppl., 28-35.

UNICEF, 2004. Le paludisme ; une cause majeur de mortalité infantile et de pauvreté en Afrique. New York n° 10017; 17pages.

Conflict of interest:

The authors state that there are no competitions of interest in this work.

Contributions of the authors

Bagalwa and Bakulikira designed the study, followed field data collection and drafted the final manuscript. Mulumeoderhwa analyzed the data statistically.