Net Journal of Social Sciences
Vol. 10(3), pp. 57-70, August 2022
DOI: 10.30918/NJSS.103.22.022
ISSN: 2315-9774
Full Length Research Paper

Spatial differentials in malaria infection among children aged 6 to 59 months in Burkina Faso

Tiékoun Théodore DA, Franklin BOUBA DJOURDEBBÉ* and Emmanuel EKAMBI

Institute for Population Studies (IFORD), University of Yaoundé II, Cameroon.

Accepted 21 July, 2022

ABSTRACT

Malaria is endemic in Burkina Faso with an upsurge in the rainy season. It is the leading cause of morbidity and mortality in health facilities in the country. Children, especially those aged 6-59 months, constitute the most vulnerable segment of the population. Three major climatic zones modulate its transmission in Burkina Faso and thus create strong spatial disparities. Based on 2017-2018 data from the Burkina Faso Malaria Indicator Survey (EIPBF), this study aims to contribute to the improvement of knowledge on the influence of individual and contextual factors on the spatial differentials of malaria infection in children aged 6-59 months in Burkina Faso. To verify this objective, at the descriptive level the chi2 test will be examined between the malaria attack of the child and each of the independent variables on the one hand, and on the other hand, the profile of the children suffering from malaria will be drawn up thanks to factor analysis and classification. At the explanatory level, this will be possible thanks to the multi-level analysis method. From a multi-level analysis, the results reveal that individual factors have more impact on childhood malaria infection than community factors. These have more impact than family factors. If in the meso-endemic zone, the most important explanatory factors are the place of residence and the age of the child, in the hypo-endemic zone, it is the age of the mother. While for the hyper-endemic zone, religion ranks first. Malaria control interventions should primarily target children aged 24 to 59 months living in rural areas in the meso-endemic zone. In hyper and hypo endemic areas, these interventions should focus on Christian mothers or mothers of other religions and mothers aged 15 to 24 years.

Keywords: Child, spatial differentials, malaria, endemic zone, Burkina Faso.

*Corresponding author. E-mail: djourdeb@yahoo.fr.

INTRODUCTION

Malaria is the most prevalent parasitic infection in the world and it is equally the first cause of death. Statistics revealed that in 2020, there were 241 cases of malaria worldwide and 627,000 deaths by malaria (World Health Organization, 2022). It is a deadly pathology caused by a parasite of the plasmodium species which is transmitted to man via bites from the infected female Anopheles mosquito (Carnevale and Robert, 2009; Pan American Health Organization and World Health Organization, nd). Malaria infection constitutes a major risk of morbidity and mortality (Aubry and Gaüzère, 2019).

Sub-Saharan Africa remains the zone most affected by malaria despite enormous efforts geared at its eradication. The World Health Organization (2022) in 2020, 95% of all malaria cases and 96% of malaria deaths occurred in the African region. According to the European Union's 2019 Global Report on Malaria, eleven (11) countries, ten (10) of which are sub-Saharan countries host 70% of malaria morbidity and mortality. These countries are Burkina Faso, Cameroon, Democratic Republic of Congo, Ghana, Mali, Mozambique, Niger, Nigeria and United Republic of Tanzania. The only non-sub-Saharan country that falls in the category of the eleven most affected countries is India. Children aged below 5 constitute the vulnerable group to malaria infection. In 2019, 67% of infant and child mortality were due to malaria infection (WHO, 2020).

Significant progress has been made since the ratification of the Abuja Declaration and Plan of Action of 2000 to reduce malaria infection and the heavy burden its places on the public health system (AU, 2019). In this perspective, the World Health Organization adopted the World Technical Strategy to Fight Malaria for the period 2016-2030 in its May 2015 General Assembly. This strategy has become a technical working framework for all malaria-endemic countries. This strategy is based and supported and oriented by regional and national designed programmes to fight malaria (WHO, 2020). In 2018, the African Union in partnership with Roll Back Malaria (RBM), launched a campaign aimed at the elimination of Malaria at the continental level under the theme “Zero Malaria, I comply”. This engagement was undertaken by 55 heads of States and governments. This campaign aimed to rekindle the local engagement movement in the fight against malaria (AU, 2019).

The African Union’s 2019 Global Report on Malaria indicated that AIDS Watch Africa and the Alliance of African Leaders for the Combat of Malaria are two important continental platforms for the engagement of heads of States and governments in the fight against malaria. These platforms have assumed a major role in the transmission of community, national, regional, continental and global efforts for advocacy, resource mobilization and the acceptance of messages for the fight against malaria.

Burkina Faso is the 6th most infected country in the world and the 5th in Africa in terms of the number of cases of malaria diagnosed in 2017 (WHO, 2018). In 2019, Burkina occupied the 4thposition with 4% of the number of cases (WHO, 2020). Malaria is a major public health problem in this country. It is endemic throughout the whole country, with a heightened seasonal prevalence between June and October. This seasonal peak varies between the three major geographic zones due to variations in rainfall. Rainfall lasts for three months in the North, six months in the centre and nine months in the south. The national malaria prevalence rate among children aged 6-59 months is 17% in 2017-2018 (INSD and ICF International, 2018). In 2017, it was the first cause of medical consultations (43.5%), 60.5% of hospitalization and 35.5% of deaths in health units (Ministry of Health, 2018). Children below 6-59 months and pregnant women are the most vulnerable groups to malaria infection. The transmission of malaria is seasonal and varies by climatic zones (INSD and ICF International, 2012).

This article seeks to contribute to the field of research through the analysis of individual and contextual factors for spatial differentials of malaria infection among children aged 6-59 months by endemic zone. An improved understanding of both the individual as well as the contextual factors of differential malaria infections will help to guide public policy in order to reduce malaria-related morbidity and deaths among children.

CONTEXT, DATA AND METHODS

Study zone and sample

Burkina Faso is subdivided into three different zones of malaria infection which coincide with the three climatic zones of the country (INSD and ICF International, 2012). The North of Burkina Faso is the Sahel Climatic type which is hypo-endemic to malaria. This domain covers 25% of the national territory with average annual rainfall between 300 and 600 mm. The rainy season lasts for less than three months. The temperature range is very high. The period for malaria transmission is very short and is potentially between 2 to 3 months.

The central part of Burkina Faso is found between latitudes 11°N and 13°N. Compared to the Sahel zone, rainfall is more abundant (600 and 900mm of annual rainfall) and the dry season lasts less than eight (8) months. Temperatures are as high as 48°C in the middle of the dry season and 23°C during the rainy season. The seasonal period for the transmission of malaria is long and stable and lasts 4 to 6 months. This zone corresponds to the meso-endemic zone (INSD and ICF International, 2012).

The Sudanese zone is located in the south. Here, rainfall is more abundant and can go above 1100mm in the course of the year. The temperature range is lower (during the dry season, temperatures vary between 28°C at night and 41°C during the day).

Burkina Faso is one of the poorest countries in the world according to the UNDP's 2019 human development report. With a Human Development Index (HDI) of 0.434, Burkina Faso occupies the 182nd position out of 189 countries (UNDP, 2020). The Burkinabe economy is dominated by the production of primary products. The growth rate of the Gross Domestic Product that comes essentially from the primary sector is +8.4%, it was estimated at 6.3 and 6.6% respectively in 2017 and 2018. In terms of sanitation, traditional latrines are places most used for defecation but by 2015, it was nature. In 2018, 38.9% of households used traditional latrines, representing an increase of 2.2 points from the 2015 percentage (INSD and AFRISTAT, 2019). The rate of sanitation is measured by the proportion of households that use improved latrines. At the national level, the sanitation rate is 35.4% (INSD and AFRISTAT, 2019). Inequality in economic and social development between regions is translated by spatial disparities in access to essential services such as health services, education, housing, etc.

Burkina Faso is an exception among Sahel regions in terms of its high religious diversity and religious tolerance (International Crisis Group (ICG) Report, 2016). Mixed marriages are common and parents are increasingly

accepting the marriage choices of their children. Inter-religious dialogue is another factor for coexistence.

Education positively influences behaviours in terms of utilisation of health services. The regular use of health services is a necessary condition for the improvement of the health of the population (Mosley and Chen, 1984; Robert et al., 2017). In Burkina Faso, the rates of literacy and school attendance are relatively low. The literacy rate in Burkina Faso is 34.7% and has increased by 1% in relation to the figure given by ENESI in 2015. It is higher in urban areas (61.2%) than in rural areas (23.9%). The education of parents, especially that of the mother influences the adoption of preventive and curative health practices which are susceptible to influencing the health of their children. Women are considered an essential resource for the health of children (Rakotondrabe, 2004; Bouba Djourdebbé, 2015).

Burkina Faso, like countries of the Sahel and West Africa, is undergoing a security crisis that is becoming more and more challenging. After a long period of relative peace, the country is progressively witnessing the degradation of its security situation. The socio-political crisis and the political transition punctuated by military-civilian tensions have rendered the security situation of the country fragile. Since 2016, the insecurity situation of the country has worsened particularly along the frontiers with Mali and Niger (West-North-east) where there has been an increase in the number of attacks by armed groups. Within this context of political instability/ crises, it has become difficult to put in place preventive and curative programmes to improve the health situation of children as well as adults. This is also true for programmes designed to fight malaria. This has resulted in interruptions of health service delivery to the population.

Data for this study comes from the Malaria Indicators Survey in Burkina Faso carried out during the period 2017-2018. The target population for this study is children aged 6-59 months at the time of the study who underwent the rapid blood test for malaria. Information was also collected from their mothers. The test was carried out on blood taken from children whose parents consented for the test to be carried out. The test (hemoglobin and malaria) was administered to all children aged 6-59 months in the selected households that accepted to take part in the survey (INSD and ICF International, 2018). A total of 6,061 children were tested but data analysis was carried out for 5,211 children (2,831 boys and 2,380 girls), representing a coverage rate of 91.48%.

Independent variables are community, household and individual variables. Community variables are the endemic nature of the zones, milieu of residence, the proportion of poor households, the proportion of educated women, the proportion of women using mosquito nets and ethnic group. Household variables are the household living standard, promiscuity within the household, use of mosquito nets within the household, type of toilet, and cleaning of the neighbourhood. Individual variables are the age of the mother, religion of the mother, mother's level of education, mother's education on malaria, use of mosquito nets, exposure to messages on malaria, and the sex and age of the child (Figure 1).

This study uses multi-level random logistic regression. The multi-level model was developed to respond to the specific problems posed by data structured on many levels (Courgeau and Bacanini, 1997; Nganawara, 2016). Studies have shown that children who share the same neighbourhood or household have some common features that can affect their risk of contracting malaria (Koné, 2012). Multi-level models assemble in the same model different levels of observation, thereby facilitating the capture of individual and context effects.

This study seeks to identify the different levels of determinants of child (6-59 months) malaria infection. This analysis will lead to a distinction between the effects of contextual and individual variables of this infection. The appropriateness of this method of analysis lies in the fact that it will provide a structured hierarchical order of the various determinants of malaria. The use of this method equally helps to minimize the various types of biases that could be brought about by simple regression analysis. Three main types of errors introduced by simple regression are taken care of in multi-level analysis. The ecological error or the bias of aggregation consists of disaggregating contextual characteristics into the individual level and aggregating the individual characteristics to the contextual level. This leads to the consideration that the context does not affect the phenomenon being studied (Givord and Guillerm, 2016). The atomic error consists of explaining a phenomenon by individual characteristics only. This takes the individual out of his or her context. Atomic error is misleading as the context largely influences the behaviours of individuals (Golaz and Bringe, 2009). To overcome this error, it is necessary to go above the level of individual trajectories and place the individual in his or her social context, that which he or she lives (the family, social network, society milieu, nation, etc.). *The third error is that of homoscedasticity of residues*, which in simple logistic regression considers that the variance of errors is identical for all individuals (Petrucci and Pini, 2015). This appears restrictive in the sense that the eventual differential effects of the environment where the individual is found are not taken into consideration.

Variables

Two tests were carried out to diagnose malaria infection among children during the survey: The Rapid Diagnostic Test (RDT) and the blood Smear Test (SMT). The RDT seeks to identify the presence or not of malaria antigens. The measure of antigens instead of parasites is due to the fact that the test will be positive during a certain time lapse after successful treatment due to the presence of residual antigens. For this reason, it gives a higher

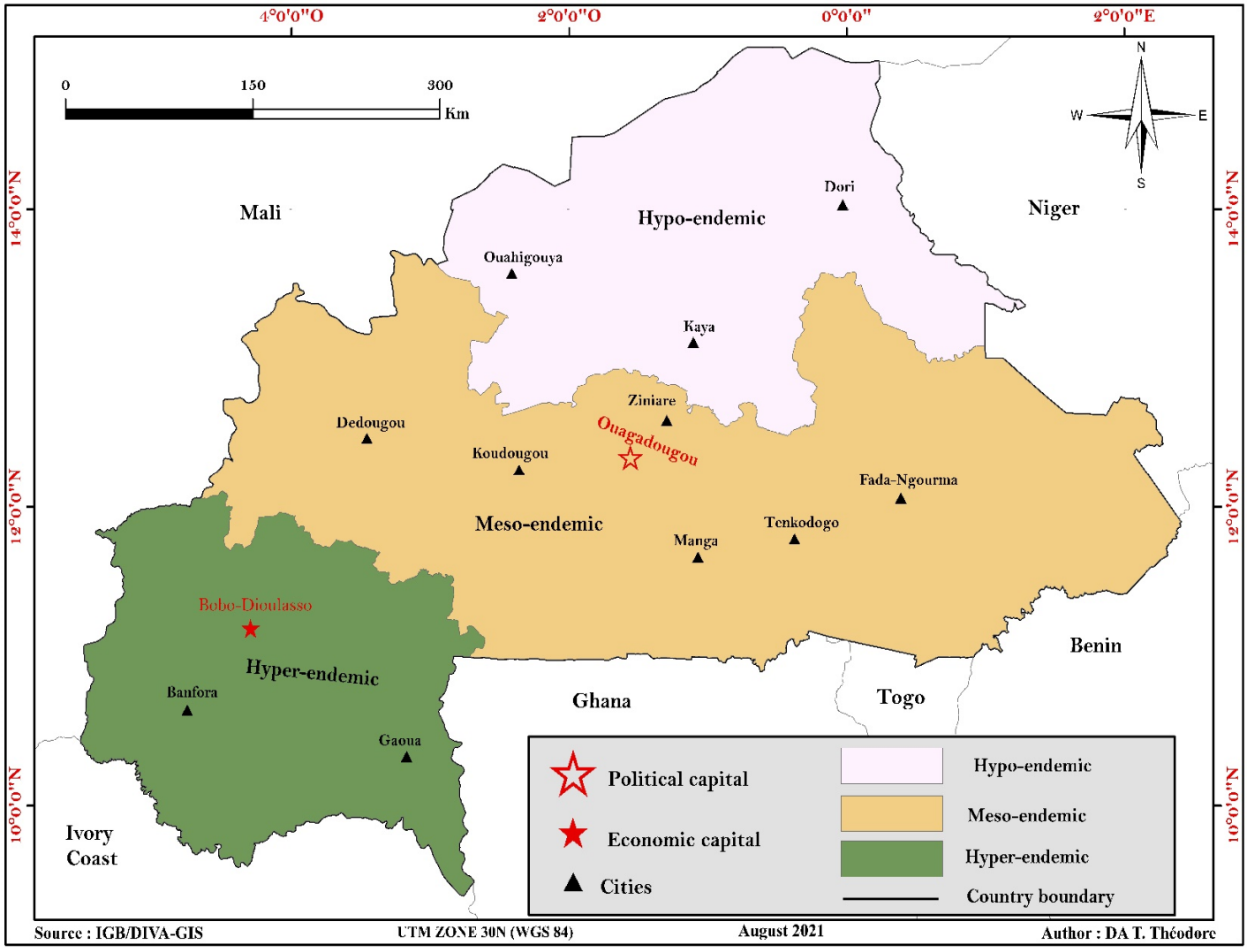

Figure 1. Classification of the 13 Administrative Regions of Burkina Faso into 3 Malaria Endemic Zones (Corresponding to 3 Climatic Domains).

infection rate than the smear blood test. The blood sample taken from the same fingertip at the same time is used for both the hemoglobin and rapid diagnostic tests. After drying, the blades were arranged and put in special boxes containing desiccative and humidity controllers, and regularly transferred to the National Reference Laboratory for the search for the presence of malaria parasite.

For this study, the malaria test obtained from the blood smear test is retained as the dependent variable because it attests to the presence (or absence) of the malaria parasite in red blood cells. This variable is a dichotomy containing two modalities. It distinguishes between the children aged 6-59 months who tested positive for the malaria parasite from those who tested negative.

Malaria endemic zones refer to the three zones of transmission in Burkina Faso. These are referred to as the hypo-endemic, meso-endemic and hyper-endemic zones. These zones correspond to the three climatic zones of the country (Carnevale and Vaugelade, 1987). Based on this, the Sahel zone corresponds to the hypo-endemic zone, the Sudanese climatic zone coincides with the meso-endemic zone and the Sudano-sahelian zone with the hyper-endemic zone. The variable on the mother's education or culture vis-a-vis malaria is a construct from 24 variables, with two on the mode of transmission,15 on its symptoms and 7 on the modes of transmission.

RESULTS

The decomposition of the variance reveals that community characteristics influence malaria infection in children in Burkina Faso (Table 1). Results of estimates from the empty model show that inter- and intra-class

Table 1. Net effects of explanatory variables of malaria infection among children 6-59 months old in the hypo-endemic zone).

Variables	Number	Proportions	M0	M1	M2	M3	M4
Child's and mother's characteristics							
Sex	***1277***	***100***					
1. Male	700	54.86		Ref.			Ref.
2. Female	576	45.14		1.123 ns			1.150 ns
Age of the child	***1277***	***100***					
1. 6-23 months	424	33.23		0.554**			0.534**
2. 24-59 months	853	66.77		Ref.			Ref.
Mother's age	***1277***	***100***					
1. 15-24 years	342	26.81		2. 911***			3. 100***
2. 25-34 years	573	44.91		Ref.			Ref.
3. 35-49 years	361	28.28		1.112 ns			1.118 ns
Mother's religion	***1277***	***100***					
1. Christian	221	17.30		1.047 ns			1.135 ns
2. Muslims	1034	80.97		Ref.			Ref.
3. Other religions	21	1.62		0.399 ns			0.460 ns
Mother's Educational Level	**1277**	**100**					
1. No Education	1024	80.18		Ref.			Ref.
2. Primary	176	13.79		0.470*			0.440*
3. Secondary and above	77	6.03		0.496 ns			0.466 ns
Exposure to messages on malaria	***1277***	***100***					
1. Exposed	793	62.12		Ref.			Ref.
2. Non exposed	484	37.88		1.068 ns			1.074 ns
Mother's culture on malaria	***1277***	***100***					
1. Low	312	24.40		0.754 ns			0.686 ns
2. Average	717	56.13		Ref.			Ref.
3. High	249	19.47		1.077 ns			1.403 ns
Use of mosquito nets	**1277**	**100**					
1. Use	812	63.59		Ref.			Ref.
2. Non-use	461	36.12		1.387 ns			1.760 ns
Household characteristics							
Availability of mosquito net(s) in the household	***1277***	***100***					
1. Available	1084	84.90			Ref.		Ref.
2. Not available	193	15.10			1.027 ns		0.568 ns
Cleaning of the environ	***1277***	***100***					
1. Cleaning	395	30.96			0.786 ns		0.755 ns
2. No cleaning	881	69.04			Ref.		Ref.
Type of toilet	***1277***	***100***					
1. Improved	675	52.88			Ref.		Ref.
2. Unimproved	602	47.12			0.863 ns		0.817 ns

Table 1. Continues.

Promiscuity in the household	***1277***	***100***					
2 persons/sleeping room	142	11.10			0.528 ns		0.465*
3 persons/sleeping room	511	40.06			0.709 ns		0.716 ns
More than 3 persons/sleeping room	624	48.84			Ref.		Ref.
Household living standard	***1277***	***100***					
1. Low	590	46.19			Ref.		Ref.
2. Average	488	38.22			0.480***		0.477**
3. High	199	15.59			1.134 ns		1.251 ns
Community characteristics							
Milieu of residence	***1277***	***100***					
1. Urban	113	8.83			0.727 ns		0.667 ns
2. Rural	1164	91.17			Ref.		Ref.
Proportion of poor households	***1277***	***100***					
1. Low	514	40.23			0.975 ns		0.993 ns
2. High	763	59.77			Ref.		Ref.
Proportion of educated women	***1277***	***100***					
1. Low	897	70.21			Ref.		Ref.
2. High	380	29.79			0.717 ns		0.688 ns
Proportion of women using mosquito nets	***1277***	***100***					
1.Low	783	61.34			Ref.		Ref.
2. High	494	38.66			0.947 ns		1.034 ns
Number	**1277**	**1277**	**1277**	**1277**	**1277**	**1277**	**1277**
Individual level variance			$\pi^2/3$	$\pi^2/3$	$\pi^2/3$	$\pi^2/3$	$\pi^2/3$
Household Level Variance			3.018	3.097	3.266	3.030	3.333
Community level variance			1.326	1.360	1.500	1.337	1.581
Intra class coefficient (ICC) at household level			56.91	57.54	59.16	57.03	19.27
Intra class coefficient (ICC) at community level			17.37	17.56	18.62	17.46	59.90
Statistical test							
Wald Chi-Square			**21.01*** **	**10.86*** **	**0.96*** **		**29.90*** **
LR Chi-Square Test (())			**83.62*** **	**77.22*** **	**86.24*** **	**81.51*** **	**78.66*** **

variables are significant. In this light, the considered household and community significantly improve upon the understanding of the influence of explanatory factors on malaria prevalence among children aged 6-59 months old. Also, the degree of homogeneity analysed based on the intra-group (class) correlation coefficient shows a resemblance among children of the same group. This result justifies the relevance of using the multi-level logistic regression analysis instead of the classic one.

The introduction of individual and contextual characteristics in the regression helps in the identification of intermediate or mediating factors that influence the factors of exposure to malaria infection among children aged 6-59 months. After introducing all individual and contextual factors in the empty model and applying the Chi-square test, the result revealed by the model explains all the differences in exposure of children aged 5 to 59 months to malaria infection (Table 1: Model M4; Table 2:

Table 2. Net effects of explanatory variables for malaria infection among children aged 6-59 months in the meso-endemic zone.

Variables	Number	Proportions	M0	M1	M2	M3	M4
Child's and mother's characteristics							
Child's sex	***2779***	***100***					
1. Male	1410	50.74		Ref.			Ref.
2. Female	1369	49.26		0.777*			0.782*
Child's age	***2779***	***100***					
1. 6-23 months	909	32.70		0.623***			0.627***
2. 24-59 months	1870	67.30		Ref.			Ref.
Mother's age	*2779*	*100*					
1. 15-24 years	653	23.51		1.028 ns			0.946 ns
2. 25-34 years	1395	50.19		Ref.			Ref.
3. 35-49 years	731	26.30		1.117 ns			1.120 ns
Mother's religion	***2779***	***100***					
1. Christian	1035	37.27		0.893 ns			0.869 ns
2. Muslim	1642	59.10		Ref.			Ref.
3. Other Religions	96	3.45		1.658 ns			1.130 ns
Mother's educational level	***2779***	***100***					
1. None	2161	77.78		Ref.			Ref.
2. Primary	343	12.35		1.139 ns			1.279 ns
3. Secondary and above	274	9.87		0.624 ns			1.031 ns
Exposure to messages on malaria	***2779***	***100***					
1. Exposed	1894	68.17		Ref.			Ref.
2. Not exposed	884	31.83		1.488**			1.430*
Culture on malaria	***2779***	***100***					
1. Low	278	9.99		1.538 ns			1.490 ns
2. Average	1710	61.53		Ref.			Ref.
3. High	791	28.48		1.082 ns			1.101 ns
Use of mosquito net	***2779***	***100***					
1. Use	1734	62.40		Ref.			Ref.
2. No Use	1029	37.05		1.108 ns			0.975 ns
Household Characteristics							
Availability of mosquito nets	***2779***	***100***					
1. Availability	2222	79.97			Ref.		Ref.
2. Non-availability	557	20.03			1.147 ns		1.148 ns
Cleaning of living environ	***2779***	***100***					
1. Clean	815	29.32			0.952 ns		0.947 ns
2. Does not clean	1959	70.49			Ref.		Ref.
Type of toilet	***2779***	***100***					
1. Improved	1176	42.33			0.548***		0.734 ns
2. Non improved	1602	57.64			Ref.		Ref.
Household promiscuity	***2779***	***100***					

Table 2. Continues.

2 persons/sleeping room	246	8.86			0.807 ns		0.796 ns
3 persons/sleeping room	1150	41.38			0.834 ns		0.846 ns
More than 3 persons/sleeping room	1383	49.77			Ref.		Ref.
Household living standard	***2779***	***100***					
1. Low	1032	37.16			Ref.		Ref.
2. Average	986	35.48			0.993 ns		1.079 ns
3. High	760	27.36			0.502***		0.658 ns
Community characteristics							
Milieu of residence	***2779***	***100***					
1. Urban	414	14.90				0.105***	0.132***
2. Rural	2364	85.10				Ref.	Ref.
Proportion of poor households	***2779***	***100***					
1. Low	1481	53.29				Ref.	Ref.
2. High	1298	46.71				1.895***	1.593*
Proportionof educated women	***2779***	***100***					
1. Low	1795	64.59				Ref.	Ref.
2. High	984	35.41				1.085 ns	1.067 ns
Proportion of women using mosquito nets	***2779***	***100***					
1. Low	1695	61.00				Ref.	Ref.
2. High	1084	39.00				1.134 ns	1.121 ns
Number	**2779**	**2779**	**2779**	**2779**	**2779**	**2779**	**2779**
Individual level variance			$\pi^2/3$	$\pi^2/3$	$\pi^2/3$	$\pi^2/3$	$\pi^2/3$
Household level variance			2.878	2.919	2.868	2.831	2.837
Community level variance			1.409	1.347	1.158	0.884	0.900
Intra-class coefficient (ICC) at household level			56.58	56.46	55.03	55.03	53.18
Intra class coefficient (ICC) at the community level			13.60	17.82	15.83	12.62	12.81
Statistical Tests							
Wald's Chi-Square Test				**25.68*** **	**19.84*** **	**37.96*** **	**58.48*** **
LR Chi-Square Test			**245.84*** **	**231.41*** **	**208.89*** **	**174.53*** **	**164.04*** **

Model M4; Table 3: Model M4).

This model reveals that after considering all explanatory variables, the child's sex and age, the mother's age, exposure to education on malaria, the milieu of residence, mother's educational level, the proportion of poor households, promiscuity, household living standard, religion and the type of toilet facility significantly influence a child's risk of malaria infection in different endemic zones.

The child's sex has no significant effect on the risk of malaria infection except in the meso-endemic zone. Everything being equal, girls are 22% less at risk of being infected by malaria compared to boys at a 10% significance level. However, there is no significant difference in the risk of malaria infection between the boy and girl children aged 6-59 months in the hypo-endemic and hypo-endemic zones (Table 1: model M4; Table 2: model M4; Table 3: model M4).

The child's age has a net effect on the risk of malaria infection irrespective of the type of endemic zone. Children aged 6 to 23 months are respectively 47 and 41% less likely to be infected by malaria than those aged

Table 3. Net effects of the explanatory variable for malaria infection among children 6-59 months in the hyper-endemic zone.

Variables	Number	Proportions	M0	M1	M2	M3	M4
Child and Mother's Characteristics							
Child's Sex	***1102***	***100***					
1. Male	529	48.00		0.747 ns			0.789 ns
2. Female	573	52.00		Ref.			Ref.
Child's age	***1102***	***100***					
1. 6-23 months	386	35.03		0.587**			0.595**
2. 24-59 months	716	64.97		Ref.			Ref.
Mother's age	***1102***	***100***					
1. 15-24 years	273	24.72		0.963 ns			0.900 ns
2. 25-34 years	538	48.83		Ref.			Ref.
3. 35-49 years	292	26.45		0.813 ns			0.856 ns
Mother's Region	***1102***	***100***					
1. Christian	250	22.69		1.865**			1.621*
2. Muslim	729	66.14		Ref.			Ref.
3. Other religions	113	10.23		5. 051***			3.810***
Mother's education	***1102***	***100***					
1. None	793	71.97		Ref.			Ref.
2. Primary	173	15.72		0.650 ns			0.765 ns
3. Secondary and above	136	12.31		0.273***			0.372**
Exposure to messages about malaria	***1102***	***100***					
1. Exposed	520	47.15		1.374 ns			1.357 ns
2. Not exposed	583	52.85		Ref.			Ref.
Education on Malaria	***1102***	***100***					
1. Low	95	8.65		1.327 ns			1.373 ns
2. Average	727	65.91		Ref.			Ref.
3. High	280	25.44		0.708 ns			0.630 ns
Use of mosquito nets	***1102***	***100***					
1. Use	642	58.24		Ref.			Ref.
2. Does not use	459	41.61		1.309 ns			1.496 ns
Household Characteristics							
Availability of Mosquito Nets	***1102***	***100***					
1. Availability	802	72.74			Ref.		Ref.
2. Not Availability	300	27.26			0.929 ns		0.691 ns
Cleaning of the environ	***1102***	***100***					
1. Cleaning	364	33.05			0.910 ns		1.283 ns
2. No Cleaning	738	66.93			Ref.		Ref.
Type of toilet	***1102***	***100***					
1. Improved	667	60.48			Ref.		Ref.
2. Unimproved	435	39.46			2. 415***		1.522*
Household promiscuity	***1102***	***50.58***					

Table 3. Continues.

2 persons/sleeping room	86	7.78			0.803 ns		0.837 ns
3 persons/sleeping room	459	41.64			0.747 ns		0.761 ns
More than 3 persons/sleeping	558	50.58			Ref.		Ref.
Household living standard	***1102***	***100***					
1. Low	553	50.17			0.862 ns		0.813 ns
2. Average	439	39.84			Ref.		Ref.
3. High	110	10.00			0.954 ns		1.098 ns
Community Characteristics							
Milieu of residence	***1102***	***100***					
1. Urban	291	26.37				0.115***	0.230***
2. Rural	812	73.63				Ref.	Ref.
Proportion of poor households	***1102***	***100***					
Low	420	38.14				Ref.	Ref.
High	682	61.86				1.398 ns	1.385 ns
Proportion of educated women	***1102***	***100***					
1. Low	629	57.08				Ref.	Ref.
2. High	473	42.92				1.319 ns	1.032 ns
Proportion of women using mosquito net	***1102***	***100***					
1. Low	652	59.18				Ref.	Ref.
2. High	450	40.82				1.404 ns	1.198 ns
Number	**1102**	**1102**	**1102**	**1102**	**1102**	**1102**	**1102**
Individual level variance			$\pi^2/3$	$\pi^2/3$	$\pi^2/3$	$\pi^2/3$	$\pi^2/3$
Household level variance			0.896	1.074	1.003	0.883	1.035
Community level variance			1.305	0.418	0.808	0.526	0.221
Intra class coefficient (ICC) at household level			40.08	32.62	35.50	30.00	27.62
Intra class coefficient (ICC) at community level			23.76	10.62	15.84	11.21	4.86
Statistical tests							
Wald's Chi-Square Test				**42.75*** **	**14.97*** **	**29.24*** **	**66.21*** **
LR Chi-Square Test (())			**69.31*** **	**27.84*** **	**41.63*** **	**35.23*** **	**17.73*** **

24 to 59 months in hypo and hyper-endemic zones, they are at a 5% significant level. In the meso-endemic zone, the influence of the age of the child is most influential. In fact, at a 1% significant level, children aged 6 to 23 months are 37% less likely to be infected by malaria compared to their counterparts aged 24 to 59 months (Table 1: model M4; Table 2: model M4; Table 3: model M4).

Apart from the hypo-endemic zone, the age of the mother has no significant net effect on a child's risk of malaria infection. Everything being equal, children with mothers aged 15 to 24 years are 3.1 times more exposed to the risk of malaria infection than children whose mothers are 25 to 34 years old. However, there is no significant difference in the risk of malaria infection between children whose mothers are 15 to 24 and 25 to 34 years old in the meso- and hyper-endemic zones. Also, there is no significant difference in the likelihood of malaria infection between children with mothers aged 34 to 39 and those with mothers aged 25 to 34 (Table 1: model M4; Table 2: Model M4; Table 3: Model M4).

The mother's educational level significantly influences the risk of malaria infections in all malaria endemic zones except the meso-endemic zone. Children whose mothers

have primary education are 56% less likely than those whose mothers have no education to be infected by malaria at a 10% significant level in the hypo-endemic zone. However, no significant difference is observed between children whose mothers have secondary education and more, and children whose mothers have no education at a 5% significant level. In the hyper-endemic zone, children whose mothers have secondary education or more are 63% less likely to be infected by malaria compared to children whose mothers have primary or no education at a 5% significant level. There is no difference in the risk of contracting malaria between children of mothers with primary education and those of mothers with no education. In the meso-endemic zone, there is no significant difference observed in the risk of contracting malaria between children born to mothers with secondary education and above, primary or no educational level (Table 1: Model M4; Table 2: Model M4; Table 3: Model M4).

The mother's religion has no significant effect on children's risks of malaria infection in the other two zones except in the hyper-endemic zone. Everything being equal, children whose mothers are of other religions are 3.81 times more likely to contract malaria compared to children of Muslim mothers at a 1% significant level. Children of Christian mothers are 1.621 times more likely to contract malaria compared with their counterparts whose mothers are of the Muslim faith at a 19% significant level. There exists no significant difference in terms of the likelihood of contracting malaria among children whose mothers are of the Christian or other religious backgrounds and those whose mothers are of the Muslim religion in the meso- and hyper-endemic zones (Table 1: Model M4; Table 2: Model M4; Table 3: Model M4).

Apart from the meso-endemic zone, exposure of mothers to messages on how to fight malaria has no significant net effects on children's malaria infection. Children whose mothers have no access to messages on how to fight are 1.43 times more likely to contract malaria than those whose mothers have this access at a 10% significant level. However, no significant difference is observed between children whose mothers have no access to messages about malaria and those whose mothers have access in the hypo and hyper-endemic zones (Table 1: Model M4; Table 2: Model M4; Table 3: Model M4).

Apart from the hypo-endemic zone, household living standards have no net significant effect on malaria infection among children aged 6-59 months. Children from households with average living standards are 52% less likely to contract malaria than those living in households with low living standards at a 1% significant level. However, there is no significant difference observed between children living in households with high or average living standards and those living in households with low living standards in terms of exposure to risks of contracting malaria. Standards in other zones have no significant influence on malaria infection among children aged 6-59 months (Table 1: Model M4; Table 2: Model M4; Table 3: Model M4).

Irrespective of the endemic zone considered, promiscuity within households has no significant effect on children's risk of contracting malaria. In order words, no significant difference exists in terms of the likelihood of contracting malaria between children living in households with 2 or 3 persons per sleeping room and those living in households with more than 3 persons per sleeping room in all endemic zones (Table 1: Model M4; Table 2: Model M4; Table 3: Model M4).

Apart from the hyper-endemic zone, the type of toilets used by households has no net significant influence on children's risks of contracting malaria. In other words, children living in households with unimproved toilet facilities are 1.52 times more likely to contract malaria compared to those who live in households with improved toilet facilities at a 1% significant level. There is no significant difference observed in terms of the risk of malaria infection between children from households that use improved and unimproved toilet facilities in both the hypo and meso-endemic zones (Table 1: Model M4; Table 2: Model M4; Table 3: Model M4).

The milieu of residence has a net significance on the risk of contracting malaria by children aged 6-59 months in all endemic zones with the exception of the hypo-endemic zone. Children living in rural areas in the Meso-endemic zone are 87% less likely to be infected by malaria compared to those living in urban areas and children living in rural areas in the hyper-endemic zone are 77% more likely to be infected than their urban counterparts at a 1% significant level. In the hypo-endemic zone, there is no significant difference observed in the likelihood of contracting malaria between children living in urban and rural areas (Table 1: Model M4; Table 2: Model M4; Table 3: Model M4).

With the exception of the meso-endemic zone, the proportion of poor households in a community (cluster) presents no significant net effects on the risk of contracting malaria by children. Children living in clusters where the proportion of rich households is high are 1.593 times more likely to contract malaria compared to those in communities with high proportions of poor households at a 10% significant level. In hyper- and hypo-endemic zones, there is no significant difference in terms of the risk of malaria infection among households living in communities with either high or low proportions of rich households (Table 1: Model M4; Table 2: Model M4; Table 3: Model M4).

DISCUSSION AND CONCLUSION

The analysis of determinants of differential malaria infection among children aged 6-59 months have

revealed many explanatory factors. Notably, children whose mothers have no education are more exposed to the risk of contracting malaria than those whose mothers have primary or secondary education and above except in the meso-endemic zone. Mothers with secondary education (or higher) pay greater attention to child health, especially during the first five years of life. Education facilitates the breakaway from beliefs and behaviours that expose children to infections and death (Beninguissé et al., 2010). Other studies have equally revealed that as the education of the mother increases the risk of exposure of children to malaria diminishes. A higher educational level for mothers attenuates the effects of tradition and unfavourable practices on child health (Franckel, 2004). The educational level of the mother influences the behaviour of the household in relation to health (Rakotondrabe, 2004). Education opens the women to the exterior and largely determines the abandonment of traditional practices that are harmful to the health of the child (Soura, 2009). Educated mothers readily accept and correctly apply attitudes and guidelines for malaria prevention (Pierrat, 2010). Mother's education influences the acquisition of household knowledge, and practices in relation to malaria-related morbidity (Takudzwa, 2018).

Children whose mothers are exposed to messages on how to fight malaria face fewer risks of malaria infection compared to children whose mothers are not exposed to these messages in the meso-endemic zone. The same situation is observed in the hypo-endemic zone, even though the difference in risk is less significant. This result is in accordance with that obtained by Wanzira et al. (2017) in Uganda. This result is plausible when we consider the fact that these messages provide communication for behaviour change which permits mothers to acquire knowledge on how to handle malaria. This result brings into focus the need for greater sensitization of the population on malaria-related risks. In the hyper-endemic zone, children of mothers who are exposed to these messages face less risk of malaria infection even though this difference is not significant.

The results of this study show that generally during the first 5 years of life, boys are more exposed to the risks of contracting malaria than girls. However, in the hypo- and the hyper-endemic zones, girls are more exposed than boys but the difference is not significant. The fact that boys are more exposed to risks of malaria infection may be due to the fact that boys easily adopt risky behaviours and the greater care accorded to girls than boys. In 2020, Sidiki found a similar result. In the same vein, higher male children mortality was observed by hospital data from the region of Kindia (Diallo, 2016).

The high degree of exposure of children of mothers aged 34-39 years to risks of contracting malaria could be accounted for by the reduction in the care accorded to children by mothers as the number of children increases. On the contrary, the high level of exposure of children born from adolescent mothers to malaria infection can be attributed to insufficient experience in handling children. These results are in line with those obtained in a study carried out in Guinea (Sidiki, 2020; Diallo, 2016). With the exception of the hyper-endemic zone, children whose mothers are less exposed to the risks of malaria-related deaths and morbidity come from mothers aged 25 to 34.

Apart from the hypo-endemic zone, children most likely to be infected by malaria are those whose mothers are non-Moslems. In the same perspective, some studies show that cultural factors play key roles in the analysis of determinants of mortality. Traditions, norms, and cultural practices influence child mortality through behaviours, attitudes and beliefs that affect individuals (Akoto, 1989, 1993; Cantrelle and Locoh, 1990).

With the exception of the hypo-endemic zone, this study has revealed that children from households that use unimproved toilets are at greater risk of malaria infection than children from households that use improved toilets. In 2019, Kaboré arrived at the same conclusion. Water from unimproved toilets sometimes stagnates in yards or holes dug by members of the household. Anopheles mosquitos have a high adaptation capacity (Capelle, 2007). This used water which stagnates becomes a breeding site for mosquitos. Nevertheless, the differences are insignificant in the meso-endemic zone. In the hypo-endemic zone, children from households that use improved toilets are more exposed to malaria infection. In Burkina Faso, this situation may come from the wrong use and insufficient maintenance of toilets. Instead of these toilets being healthy, poorly maintained toilets become breeding grounds for mosquitoes that bring malaria to users.

In Burkina Faso, other religions are dominated by animists. Beliefs and perceptions in relation to malaria infection by populations may determine behaviour that may favour the exposure of children to the illness.

Children from households where a sleeping room is shared by more than 3 persons face a greater risk of malaria infection than children from households with 2 or 3 persons per sleeping room. However, this difference is not significant in meso- and hyper-endemic zones. These results corroborate with those of other researchers who have demonstrated that promiscuity increases the risk of malaria infection among children (Fournier and Haddad, 1995; Maud, 2006; Pierrat, 2010; Takudzwa, 2018).

With the exception of the hypo-endemic zone, children living in urban areas are less likely to be infected by malaria compared to those living in other areas. This result aligns with those obtained by Sandie (2014) in Cameroon, Barry (2015) in Guinea, Diallo (2016) in Mali and Kabore (2019) in Burkina Faso. Conditions in the rural milieu are favourable for the development of mosquitoes (Pages et al., 2007). Rural spaces are spaces with high risks of multiple mosquito bites (Daval, 2006). Because of low population densities in rural areas, each individual can be infected by malaria many

times a year (Gazin, 1991). However, differences in the risk of exposure to malaria infection by the milieu of residence are not significant in the hypo-endemic zone.

The difference in the risk of contracting malaria between rural and urban areas is most important in the meso-zone which is the most urbanized in Burkina Faso. These results show that the level of urbanization contributes to explaining the spatial differentiation in malaria prevalence among children aged 6-59 months in Burkina Faso in 2018. Studies have emphasized the fact that urbanization limits the risk of malaria infection because it renders the environment artificial. This reduces the habitat for the propagation of the larvae of the anopheles mosquito (Gazin, 1991; Pages et al., 2007). The pollution of surface water in urban areas hinders the development of anopheles mosquitoes (Loizzo and Tabarly, 2012; Fournet et al., 2015).

Urbanization equally implies the evolution of behaviours that are translated more efficiently into malaria prevention methods (use of insecticides, use of mosquito nets and other preventive measures), availability of high-quality information and health establishments (Loizzo and Tabarly, 2012). Results of this study show that in hypo- and hyper-endemic zones children living in communities with high proportions of poor households are more exposed to the risks of malaria infection than their counterparts in communities with low proportions of poor households. Many studies have revealed that the socio-economic situation determines vulnerability to infections and the risk of death for disfavoured population groups (Maiga and Bocquier, 2016). The risk of death varies from place to place and from time to time in relation to the socio-economic conditions (Akoto, 1994; Beninguissé et al., 2010; Djourdebbé, 2015). However, in the hypo- and hyper-endemic zones, the differences are not significant.

REFERENCES

Akoto, E. (**1993**). Déterminants socioculturels de la mortalité des enfants en Afrique Noire : Hypothèses et recherche d'explication. Academia, Louvain-La-Neuve, 299 p.

Akoto, E. (**1994**). Évolution et déterminants de la mortalité en Afrique, In : KOFFI N. et al. (dir.), Maîtrise de la croissance démographique et développement en Afrique, ORSTOM Éditions, Paris, pp. 49-69.

Akoto, E. M. (**1989**). Déterminants socioculturels de la mortalité des enfants en Afrique Noire. Hypothèses et recherche d'explication au Cameroun, au Kenya et au Sénégal), Thèse de Doctorat, Institut de Dermographie, Université Catholique de Louvain.

AU (**2019**). Rapport global de l'Union africaine sur le paludisme. Document de travail, Addis Abeba, 32 p.

Aubry, P., and **Gaüzere**, B.-A. (**2019**). Paludisme, Document pédagogique, Centre René Labusquière, Institut de Médecine Tropicale, Université de Bordeaux, 30 p.

Barry, T. S. (**2015**). Disparités régionales de la morbidité palustre chez les enfants de moins de 5 ans en Guinée, Mémoire de Master en Démographie, Université Yaoundé II Soa, IFORD, 140 p.

Beninguissé, G, Eloundou P, Nsoa Mbondo P., and Tanang Tchouala P. (**2010**). Les tendances de la mortalité des enfants selon le statut socio-économique en Afrique subsaharienne : effet de composition ou de performance. Chaire de Quetelet, 1-21.

Bouba Djourdebbe, F. (**2015**). Facteurs environnementaux immédiats et santé des enfants dans les zones de l'Observatoire de population de Ouagadougou, thèse enDémographie,Universitéde Montréal, 264 p.

Cantrelle, P., and **Locoh**, T. (**1990**). Facteurs culturels et sociaux de la sante en Afrique de l'Ouest, Les Dossiers du CWED no 16, Paris, CEPED. 41 p.

Capelle, A. (**2007**). Paludisme et réchauffement climatique, Mémoire de 2è année en Écologie Humaine et Santé, Université Paul Cézanne Aix-Marseille, 32 p.

Carnevale P., and **Robert** V. (**2009**). Les anophèles : biologie, transmission du Plasmodium et lutte anti vectorielle, Marseille (France), IRD Éditions, 402 p.

Carnevale, P., and **Vaugelade**, J. (**1987**). Paludisme, morbidité palustre et mortalité infantile et juvénile en Afrique sub-saharienne, WHO/MAL/87.1036, Document de travail, 20 p.

Courgeau, D., and **Baccaïni** B. (**1997**). Analyse multiniveaux en sciences sociales. Population, vol.4, pp.831-863.

Daval, C. R. (**2006**). Les maladies parasitaires en milieu urbain : intérêt et limites de l'analyse spatiale. Espace Populations Sociétés, 2(3) : 381-392.

Diallo, D. (**2016**). Disparités régionales de la morbidité palustre chez les enfants de 6-59 mois au Mali : recherche des facteurs explicatifs, Mémoire de Master en Démographie, Université Yaoundé II Soa, IFORD, 95 p.

Fournier, P., and **Haddad**, S. (**1995**). Les facteurs associés à l'utilisation des services de santé dans les pays en développement. in : HUBERT G. et PICHE V (1995), Sociologie des populations, Montréal, PUM/AUPELF-UREF, pp 289-325.

Franckel, A. (**2004**). Les comportements de recours aux soins en milieu rural au Sénégal : Le cas des enfants fébriles à Niakhar. Thèse de doctorat en Démographie, Université Paris X Nanterre, 466 p. + annexes.

Gazin, P. (**1991**). Le paludisme en Afrique au sud du Sahara : comparaison entre les milieu urbains et ruraux. Cahiers d'Études et de Recherches Francophones/Santé, 1(1) : 33-38.

Givord, P., and **Guillerm**, M. (2016). Les modèles multiniveaux, Série des documents de travail, Méthodologie statistique de la direction de la Méthodologie et de la coordination Statistique et Internationale, INSEE, 68 p.

Golaz, V., and **Bringé**, A. (2009). Apports et enjeux de l'analyse multiniveau en démographie. Actes des Journées de Méthodologie Statistique. INSEE.

INSD and **AFRISTAT** (**2019**). Enquête Régionale Intégrée sur l'Emploi et le Secteur Informel, 2018, Rapport final. INSD et AFRISTAT, Ouagadougou, Burkina Faso et Bamako, Mali, 356 p.

INSD and **ICF International** (**2012**). Enquête démographique et de santé et à indicateursmultiples (EDSBF-MICS IV) 2010, INSD et ICF international, Ouagadougou et Calverton, 501 P.

INSD and **ICF International** (**2018**). Enquête sur les indicateurs du paludisme au Burkina Faso (EIPBF) 2017-2018, Burkina Faso, Rapport d'enquête, Ouagadougou, 159p.

International Crisis Group (ICG) Report (**2016**). Burkina Faso: Preserving the Religious Balance. https://www.crisisgroup.org/africa /west-africa/burkina-faso/burkina-faso-preserving-religious-balance.

Kabore, S. T. (**2019**). Disparités régionales de la morbidité palustre des enfants de moins de 5 ans au Burkina Faso. Mémoire de Master en Démographie, Université Yaoundé II Soa, IFORD, 188 p.

Koné, K. G. (**2012**). L'équité de l'accès aux soins dans un contexte de subvention des médicaments : Une analyse économétrique des déterminants du recours aux soins à Dakar, thèse de doctorat en économie de la santé, Université Cheikh Anta Diop, 239p. + annexes.

Loizzo, C., and **Tabarly**, S. (2012). Espaces et territoires du paludisme, Document pédagogique. Géographie de la santé : espace et sociétés, Géoconfluences: http://geoconfluences.ens-lyon.fr/doc/transv/sante/Doc.htm Consulté le 05/03/2021, 12 p.

Maiga, A., and **Bocquier**, P. (**2016**). Dynamiques urbaines et santé des enfants en Afrique subsaharienne : Perspectives théorique. African Population Studies, 30(1): 2213-26. doi :10.11564/30-1-802.

Maud, C. (**2006**). Impacts des facteurs environnementaux et sociodémographiques dans la ville d'Ouagadougou (Burkina Faso). Mémoire de Master en Géographie de la santé, Université de

Nanterre,58 p. + annexes.
Ministry of Health (**2018**). Annuaire statistique de la santé 2017, Burkina Faso, Direction générale des études et des statistiques sectorielles, Document de travail, Ouagadougou, 386 p.
Mosley, H. W., and **Chen** L. C. (1984). An analytical framework for the study of child survival in Developing countries. Population and Development Review, supplement to vol.10, pp. 25-45.
Nganawara, D. (2016). Famille et scolarisation des enfants en âge obligatoire scolaire au Cameroun : Une analyse à partir du recensement de 2005, Québec, col Rapport de recherche de l'ODSEF, Université Laval, 50p.
Pages, F., Orlandi-Pradines, E., V., Corbel (**2007**). Vecteurs du paludisme : biologie, diversité, contrôle et protection individuelle. Médecine et Maladies Infectieuses, 37(3) : 153-161.
Pan American Health Organization and **World Health Organization** (**nd**). Malaria: General information. https://www3.paho.org/hq/index.php?option=com_content&view=article&id=2573:2010-general-information-malaria&Itemid=2060&lang=en.
Petrucci, F., and **Pini**, G. (**2015**), Du modèlemultiniveauclassique au modèlemultiniveau de croissance, Document de travail, Groupe Édumétrie de la SSRE, 62p.
Pierrat, C. (2010). Des moustiques et des hommes, thèse en Géographie. Université Paris 1 Panthéon Sorbonne, 149 p + annexes.
Rakotondrabe, F. P. (2004). Statut de la femme et santé des enfants à Madagascar. Thèse de Doctorat en Démographie, Université de Yaoundé II Soa, IFORD (Cameroun), 370 p.
Robert, E., Samb, O. M., Marchal, B., and Ridde, V. (2017). Building a middle-range theory of free public healthcare seeking in sub-Saharan Africa: A realist review. Health Policy Plan, 7(32): 1004-1014.
Sandie, A. B. (**2014**). Les déterminants de l'infection palustre chez les enfants demoins de 5 ans dans la région du nord Cameroun. Mémoire de Master en Démographie, Université de Yaoundé II Soa, IFORD, 99 p.
Sidiki, K. (**2020**). Influence des facteurs individuels et contextuels sur l'évolution de la mortalité des enfants de moins de 5 ans en Guinée. Mémoire de Master en Démographie, Université de Yaoundé II Soa, IFORD, 220 p.
Soura, B. A. (**2009**). Analyse de la mortalité et de la santé des enfants à Ouagadougou : inégalités spatiales, effets individuels et effets contextuels, Louvain-la-Neuve. Presses universitaires de Louvain, 335 p.
Takudzwa, D. (**2018**). Household determinants of malaria in Mutasa District of Zimbabwe. Thesis in Public Health, Walden University,172 p.
UNDP (**2020**). Rapport 2019 sur le développement humain au Burkina Faso. Ouagadougou, 32 p.
Wanzira, H. Katamba, H., Okullo, A. E., Agaba, B., Kasule, M., and Rubahika, D. (**2017**). Factors associated with malaria parasitaemia among children under 5 years in Uganda: a secondary data analysis of the 2014 Malaria Indicator Survey dataset. Malaria Journal, 16(1): 191. doi: 10.1186/s12936-017-1847-3.
WHO (**2018**). Rapport sur le paludisme dans le monde 2018. Document de travail, Genève, 210 p.
WHO (**2020**). Rapport sur le paludisme dans le monde 2020. Document de travail, Genève, 299 p.
World Health Organization (**2022**). Malaria. https://www.who.int/news-room/fact-sheets/detail/malaria.

Citation: Da, T. T., Bouba Djourdebbé, F., and Ekambi, E. (2022). Spatial differentials in malaria infection among children aged 6-59 months in Burkina Faso. Net Journal of Social Sciences, 10(3): 57-70.