Quest Journals
Journal of Research in Humanities and Social Science
Volume 10 ~ Issue 9 (2022) pp: 312-323
ISSN(Online):2321-9467
www.questjournals.org

Research Paper

The Determinants Of The Use Of Malaria Prevention Methods In The Town Of Gagnoa (Central-Western Ivory Coast)

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ABSTRACT
Malaria is rife in the humid tropics. In Côte d'Ivoire, and particularly in Gagnoa, it is the leading cause of mortality and morbidity. Although the disease is known to the population, the means of prevention differ according to social strata. This study aims to show the determinants of the use of means of prevention of malaria in Gagnoa. It is based on documentary research and a field survey. The Sphinx analysis software and Karl Pearson's Chi-2 test were used to identify the determinants of the use of preventive measures against malaria. It emerged that there is a diversity of means of controlling malaria vectors. Long-lasting impregnated mosquito net (52.19%), aerosol cans (15.76%), smoke coils (12.32%) and ventilators (10.86%) are the main means of malaria prevention. By taking into account the variables of income level, education, and the number of rooms in the household, which determine the standard of living of the heads of households surveyed in Gagnoa, the Karl Pearson Chi-2 test revealed their influence on the choice of malaria prevention methods. Of all these variables, the income of the head of the household was the most influential because when it was high, it gave more capacity and possibility to use adequate prevention measures. There are determinants that influence the use of malaria control strategies that need to be integrated into control policies and programmes for greater effectiveness.

Keywords: *Gagnoa, malaria, determinants, means of prevention, standard of living*

LES DÉTERMINANTS DE L'UTILISATION DES MOYENS DE PRÉVENTION DU PALUDISME DANS LA VILLE DE GAGNOA (CENTRE-OUEST DE LA COTE D'IVOIRE)

RESUME
Le paludisme sévit dans les zones tropicales humides. En Côte d'Ivoire et particulièrement à Gagnoa, il constitue la première cause de mortalité et de morbidité. Bien que la maladie soit connue des populations, les moyens de prévention diffèrent selon les couches sociales. Cette étude vise à montrer les déterminants de l'utilisation des moyens de prévention du paludisme à Gagnoa. Elle repose sur la recherche documentaire et l'enquête de terrain. Le logiciel d'analyse Sphinx et le test Khi-2 de Karl Pearson ont permis de mettre en évidence les déterminants d'utilisation des moyens préventifs du paludisme. Il ressort, qu'il existe une diversité de moyens de lutte contre les vecteurs du paludisme. Les MILDA (52,19%), les bombes aérosols (15,76%), les serpentins fumigènes (12,32%) et les ventilateurs (10,86%) constituent les principaux moyens de prévention du paludisme. En prenant en compte les variables du niveau de revenu, d'instruction, du nombre de pièces dans l'habitat du ménage qui déterminent le niveau de vie des chefs de ménages enquêtés à Gagnoa, le test de Khi-2 de Karl Pearson a mis en évidence leurs influences dans le choix des moyens de prévention du paludisme. De toutes ces variables, le revenu du chef de ménage a été le plus influent car lorsqu'il était élevé, il donnait plus de capacité et de possibilité d'utiliser les mesures de prévention adéquates. Il existe des déterminants qui influencent l'utilisation des stratégies de lutte contre le paludisme qu'il faut impérativement intégrer dans les politiques et programmes de lutte pour plus d'efficacité.

Mots-clés : Gagnoa, paludisme, déterminants, moyens de prévention, niveau de vie

***R**eceived 12 Sep., 2022; **R**evised 25 Sep., 2022; **A**ccepted 28 Sep., 2022 © The author(s) 2022.*
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I. INTRODUCTION

Malaria is a global public health problem. In 2018, the estimated number of malaria cases worldwide was 228 million with 405,000 deaths. But among the regions of the world, the African continent remains the most affected. Indeed, in 2018, the WHO Office for the region announced that 213 million, or 93% of those affected and 94% of malaria-related deaths occurred in Africa. The African context seems to explain such percentages. In Africa, people are unable to ensure a decent, clean living environment free from the spread of malaria pathogens, especially the poorest and most marginalised communities. They have less access to preventive measures and medicines. These populations are thus at risk of malaria.

Poverty is generally a situation in which a person does not have sufficient resources to maintain or access a normal lifestyle (S. Alkire *and al.,* 2016, p. 3). Thus, poverty is considered a multidimensional phenomenon. Ivory Coast does not shy away from this reality that affects Africa.

The number of poor people has increased tenfold in the space of a generation. One person in two is poor today, compared to one person in ten in 1985. Indeed, poverty has been trending upwards from 10% in 1985 to 46.3% in 2015 (ENV, 2015, p. 9 and p. 27b). Other factors account for the persistent level of poverty in Côte d'Ivoire. Beyond the negative effects of the crises, several structural and social factors continue to keep a large part of the Ivorian population in the poverty trap. These include the lack of education, the high size of households, the precariousness of housing, the deterioration of the living environment (ENV, 2015 p. 42-48). This situation is observed throughout the national territory and particularly in the town of Gagnoa. According to the 2015 National Living Standards Survey, the Gôh region is one of the poorest regions in Côte d'Ivoire. From this survey, it appears that the poverty ratio in urban areas of the Gôh region was 53.3% with a poverty rate of 26.8% for the city of Gagnoa (INS, 2014).

Malaria is one of the intractable public health problems in this country. It is the leading cause of medical consultations in Ivorian health facilities. According to statistics published by the RASS (Rapport Annuel sur la Situation Sanitaire) in 2017, 43 out of every 100 people consulted a doctor because of clinical signs resembling malaria. The national incidence in children under 5 years of age is increasing, from 281.8‰ in 2017 to 492.9‰ in 2018. Malaria incidence in the general population increased from 164.1‰ in 2017 to 189.9‰ in 2018, an increase of 15‰ (RASS, 2019, p. 127 and p. 132) with a mortality of 33% in 2018 (PNLP-CI, 2018). This overview of national statistics contrasts with those at regional scales. At the scale of the city of Gagnoa, the incidence of malaria, which was 133.02‰ in 2009, decreased to 125.44‰ in 2018 ; a slight regression (District Sanitaire de Gagnoa, 2019). This regression, although insignificant, bears evidence of national policies put in place to reduce malaria and its effects on the population. The Ivorian state is not inactive in the fight against this disease which constitutes a public health challenge.

In 1999, following the example of other endemic countries in Africa, Ivory Coast joined the global initiative to "Roll Back Malaria". In order to promote the implementation of effective interventions in favour of the populations, on 25 April 2000, it adhered to the Abuja Plan on Malaria Control adopted by the African Heads of State (PNPL-CI, 2015, p. 35). At that time, the country prioritised access to adequate, effective and affordable treatment for all people with malaria, especially pregnant women and children under five. In this approach, three dimensions characterise the management of malaria : diagnosis, curative treatment of malaria cases and prevention, which aim to effectively reduce malaria-related mortality. With regard to prevention, mosquito nets are distributed en masse and routinely every two years in Côte d'Ivoire. In this dynamic, the mosquito nets distributed free of charge to households in the city of Gagnoa are counted as follows : 3 663 in 2014, 6 780 in 2016 and 4 670 in 2018. The distribution is accompanied by a communication policy on the technique of using the net (Gagnoa Health District, 2018).

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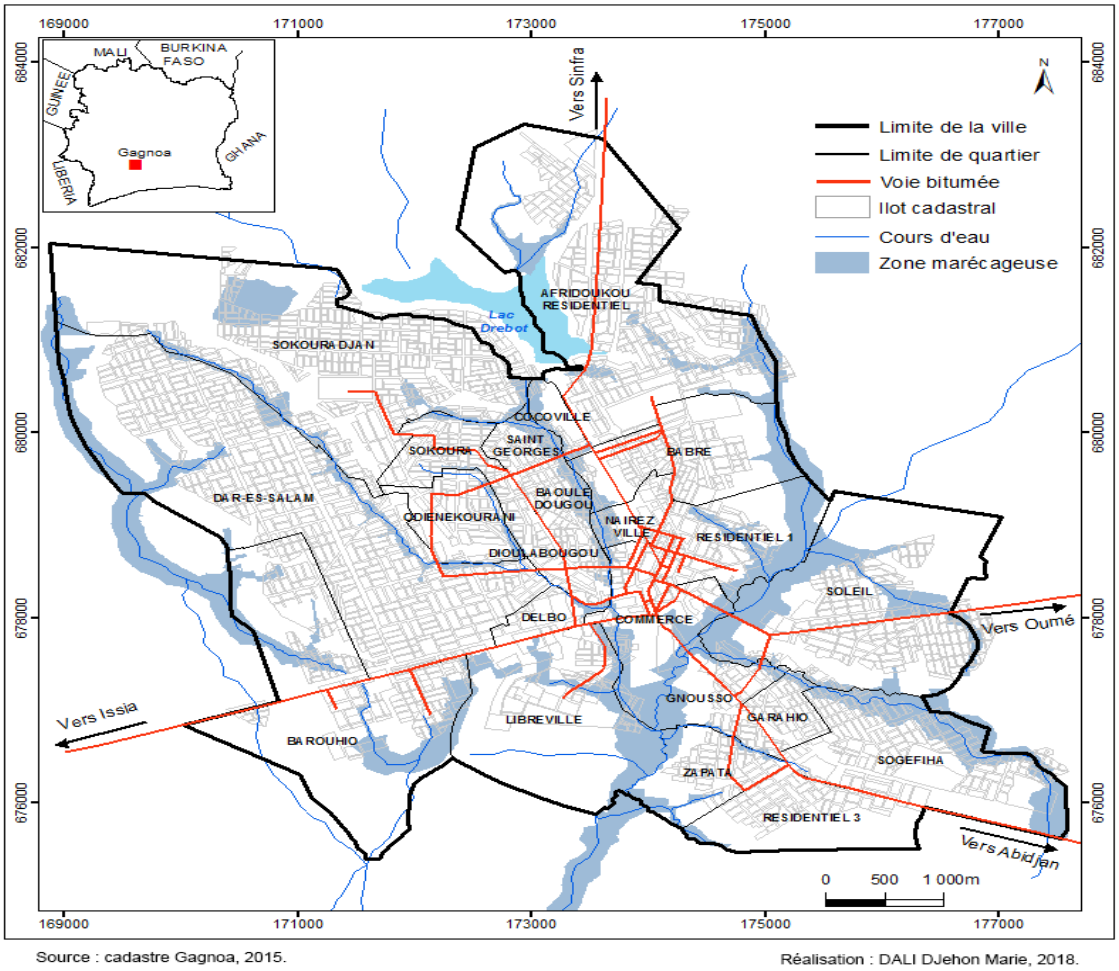
Despite all these anti-malaria actions initiated by the authorities and assisted by development partners, malaria still remains a real public health problem in the city of Gagnoa. Also, the effective use of preventive measures seems to be a function of the economic, social and demographic status of households. This study aims to show the determinants that influence the use of preventive measures against malaria in Gagnoa. Specifically, it aims to analyse the different means of malaria prevention among the population, and to identify the factors or determinants that influence the use of these measures.

II. MATERIALS AND METHODS

2.1. Study site

In terms of delimitation, our study is focused on a spatial zone located in the centre-west of Côte d'Ivoire, more precisely in the Gôh region. Located 288 km from Abidjan, the town of Gagnoa is the capital of the department and the region. It is at the intersection of five major roads linking the cities of Lakota, San-Pedro, Sinfra, Toumodi, Man and Abidjan (Figure 1). The topographical landscape of the site is characterised by the presence of numerous rivers, low-lying areas and floodplains that are likely to be breeding grounds for malaria mosquitoes (Figure 1).

On this map, the blue colour represents the swampy areas that sweep across the city from east to west and from north to south. The swampy areas occupy an area of 46.13% of the city. Clearly, the urban area of Gagnoa is surrounded by water that forms large rivers, including the Guéri, Delbo, Gnousso, etc., which are the main offshoots.



Source : cadastre Gagnoa, 2015. Réalisation : DALI DJehon Marie, 2018.

Figure 1: Location and presentation of the town of Gagnoa

2.2. Data collection and processing techniques

Two data collection techniques were used for this study : desk research and field survey. The documentary research provided information on the control strategies recommended by the health authorities, the determinants of the use of control methods, and the epidemiological situation in the town.

Statistical data (demographic and health) were collected from the National Institute of Statistics (INS), the Ministry of Health through the Gagnoa Health District and the National Malaria Control Programme. They allow us to characterise the population and monitor the epidemiological situation of malaria and to assess the control efforts. The 1:50 000 scale map of the town of Gagnoa was acquired from the Bureau National d'Études Techniques et de Développement (CCT/BNETD) and served as a guide for this study.

Field survey, interview, observation and household survey were used. The interview consisted of obtaining information on malaria control and urban planning policy from the authorities (health and administrative). As for the observation, it consisted in assessing the state of the living environment in order to grasp the extent of the factors of malaria risk, the typology of the habitat, and the sanitary facilities. It also enabled us to learn more about the control strategies developed by the populations. For the survey of heads of households, a sample was selected based on the Fisher formula, n= , $\boldsymbol{n = \frac{t^2.P(1-P)}{m^2}}$ where n = sample size; t = margin coefficient (determined from the confidence level); m = tolerated margin of error; P = proportion of households assumed to have the desired characteristics. This proportion varies between 0 and 1 and is a probability of occurrence of an event. In the case where no value of this proportion is available, it is set at 50%.

With a population of 31,570 heads of household in 2014 (NSI, 2014), 794 heads of household were surveyed according to housing type. Thus, for n high standing = (1.96)2*0.1037 (1-0.1037) / $(0.05)^2$; n= 143 heads of households. Table 1 shows the distribution of heads of households surveyed in the town of Gagnoa.

Table 1 : Distribution of households surveyed by neighbourhood

Type of habitat	District	Households surveyed
High standing	Sogefiha, Zapata R Résidentiel 1 et 2, Afridougou R et Commerce	**143**
Medium standing	Cocoville, Delbo, Gnousso Soleil, Garahio, Babré, Libreville, Nairez-ville Barouhio	**271**
Evolutionary or common	Saint-Georges, Baouledougou, Dar-es-Salam, Dioulabougou, Sokoura, Sokoura Djan, Odiennékourani	**341**
	TOTAL	755

Source : Calculated from NSI 2014 data

The rule of three was applied to allocate the number of heads of households to be surveyed by ward. To cover the city, the survey used the stepwise method. This method consists of determining a starting point and a day code for the selection of the first household to be surveyed. The other households are selected in fixed steps, of which the step skip of 5 is retained in this study because we are in an urban environment. The data collected was processed using computer tools, through the software Sphinx for the input mask, Excel for the creation of tables and graphs and ArcGis 10.2 for the design of the maps.

III. RESULTS

3.1. Different perceptions of the causes of malaria

The perception of malaria varies from one subject to another, from one community to another, from one social group to another, depending on the cultural data of each. The set of symptoms felt or presented by a subject are named in a local vocabulary. It is known as "djèkouadio or Gnindrôh" in Bété, "djokouadio" in Baoulé, "soumaya" in Malinké, "chilo" in Akyé and Abbey, djafasso in Gouro, sonh in Yacouba. This reflects the recognition of the disease in our cultures. The perception of malaria in the sampled households in the town of Gagnoa is illustrated in table 2.

Table 2 : Causes of malaria according to heads of households

Perception	Number	Pourcentage
Mosquitoes	528	69,93
Sun	74	9,80
Fatigue	46	6,09
Unhealthy environment	41	5,43
Rain	29	3,84
Excessive work	18	2,38
Excessive consumption of edible oil	15	1,99
Witchcraft	2	0,27
Mangoes	2	0,27
Total	755	100

Source : Field surveys, 2019

This table highlights the knowledge of malaria by the population of the town of Gagnoa. Indeed, 69.93% of heads of households acknowledge that malaria occurs as a result of mosquito bites. On the other hand, 9.8% attribute the cause of malaria to long exposure to the sun and 5.43% think that an unhealthy living environment is a source of malaria. Excessive work (2.38%) and fatigue (6.09%) are mentioned as the main causes of malaria in men. A minority of heads of households blamed rain (3.84%), excessive consumption of fatty foods (1.26%), witchcraft (0.27%) and excessive consumption of mangoes (0.27%) as the cause of a febrile case.

3.1.1. Distribution of the perception of malaria according to neighbourhood

The perception of malaria varies from one habitat to another. The intersection of the habitat type variable and the perception of the disease is illustrated in Table 3.

Table 3 : Distribution of heads of households according to perception of malaria and type of neighbourhood

	Type of habitat						
Perception of malaria	**High standing** (Sogefiha, Zapata R Résidentiel 1 et 2, Afridougou R and Commerce)		**Medium standing** (Cocoville, Delbo, Gnousso, Soleil, Garahio, Babré, Nairez-ville, Libreville and Barouhio)		**Evolutionary** (Saint Georges, Sokoura, Baouledougou, Dar-es-Salam, Dioulabougou, Sokoura djan, Odiennekourani)		
	Numb.	%	Numb.	%	Numb.	%	Total
Mosquito	133	93,01	208	76,75	187	54,83	528
Sun	4	2,79	22	8,13	48	14,08	74
Rain	0	0,00	10	3,69	19	5,57	46
Excessive work	2	1,40	2	0,74	14	4,11	41
Excessive consumption of red oil	0	0,00	5	1,84	10	2,93	29
Fatigue	0	0,00	14	5,16	32	9,38	18
Unhealthy environment	4	2,79	9	3,32	28	8,21	15
Mangoes	0	0,00	0	0,00	2	0,58	2
Witchcraft	0	0,00	1	0,36	1	0,29	2
Total	143	100	271	100	341	100	755

Source : Field surveys, 2019

Analysis of this table shows that 93.01% of the heads of households surveyed in the high-standard neighbourhoods recognise mosquitoes as the sole cause of malaria. This was followed by those who blamed the sun (2.79%) and an unhealthy environment (2.79%).

Among the heads of households in the middle class, 76.75% recognised Anopheles mosquitoes as the main vector for malaria transmission. On the other hand, 8.11% of households blamed the sun and 5.16% cited fatigue as the causes. Also, malaria transmission was attributed to the unhealthy environment (3.32%) and excessive consumption of fatty foods (1.84%).

As for the heads of households in the evolving neighbourhoods, 54.83% recognised mosquitoes as malaria vectors. For some, the sun (14.08%), excessive work (4.11%), fatigue (9.38%) and unhealthy environment (8.21%) are considered the only causes of malaria. These results clearly show that opinions on the causes of malaria are diverse and the importance of the causes identified depends on the type of neighbourhood. They also reveal the lack of knowledge of malaria vectors by a large part of the population.

3.2. Means of protection against mosquitoes developed by households

The households surveyed in the town of Gagnoa have a variety of protective measures against mosquitoes (Table 4).

Table 4 : Methods of protection against mosquitoes used by the households surveyed

Means of prevention	**Number**	**Pourcentage**
Long-lasting impregnated mosquito net	394	52,19
Aerosol can	119	15,76
Smoke coil	93	12,32
Fan	82	10,86
Nothing	33	4,37
Air conditioning	18	2,38
Simple cover	13	1,72
Plant with repellent essence	03	0,40
Total	755	100

Source : Field surveys, 2019

The analysis of this table shows that Long-lasting impregnated mosquito net are the most commonly used means of mosquito prevention in the town of Gagnoa. Indeed, 52.19% of the households surveyed use them. This is followed by 15.76% of those who use aerosol cans and 12.32% of those who use smoke coils. The use of fans (10.28%) and air conditioners (2.38%) was noted in households. Sanitation, which includes cleaning the living environment and draining stagnant water in the living environment, was not mentioned by the

respondents. However, to overcome this disease in our societies, a combination of several preventive measures is necessary. No single measure can effectively combat malaria vectors.

3.2.1. Distribution of heads of households according to prevention measures and neighbourhoods in the town of Gagnoa

Table 5 shows the distribution of data on malaria prevention according to the different districts.

Table 5: Distribution of heads of households according to prevention measures and type of housing

	Type d'habitat						
Means of prevention	High standing (Sogefia, Zapata R Residentiel 1 et 2, Afridougou R and Commerce)		Medium standing (Cocoville, Delbo, Gnousso, Soleil, Garahio, Babré, Nairez-ville, Libreville and Barouhio)		Evolutionary or common course (Saint Georges, Sokoura, Baouledougou, Dar-es-Salam, Dioulabougou, Sokoura djan, Odiennekourani)		
	Numb.	%	Numb.	%	Numb.	%	Total
Nothing	0	0	6	0,79	27	9,96	33
Long-lasting impregnated mosquito net	61	42,66	149	54,98	184	53,95	394
Aerosol cans	52	36,36	38	14,02	29	8,52	119
Plant with repellent essence	0	0,00	0	0,00	3	0,88	3
Air conditioning	18	12,59	0	0,00	0	0,00	18
Simple cover	0	0,00	3	1,11	10	2,93	13
Fan	11	7,69	36	13,28	35	10,26	82
Smoke coil	1	0,70	39	14,39	53	15,54	93
Total	143	100	271	100	341	100	755

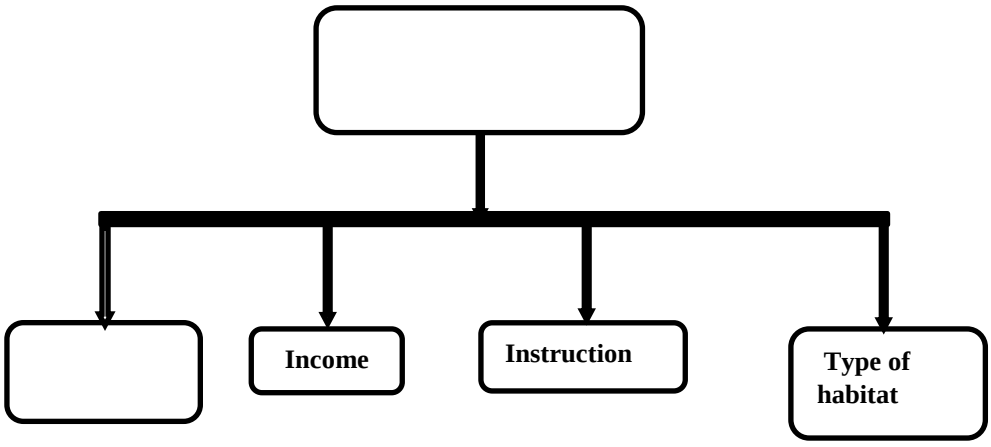
Source : Field surveys, 2019

The data in this table reveal that households surveyed in the high-standard neighbourhoods make greater use of Long-lasting impregnated mosquito net (42.66%) and spray cans (36.36%) as means of protection. The high use of Long-lasting impregnated mosquito net and spray cans is a result of the presence of senior managers in these neighbourhoods, who are able to acquire and use the means of prevention of their choice on a daily basis.

As for the medium-standard neighbourhoods, households make more use of Long-lasting impregnated mosquito net (54.98%), smoke coils (45.83%) and aerosol cans (14.02%) to prevent malaria. In the evolving districts, a variety of preventive measures were used, the most prevalent of which were Long-lasting impregnated mosquito net (53.95%), smoke coils (15.54%) and fans (10.26%). In addition, 9.96% of households in these neighbourhoods do not take any measures to protect themselves against malaria pathogens despite the risk involved.

3.3. Determinants of the use of preventive measures

In the context of this study, a determinant is defined as a factor that can constitute an obstacle in the use of malaria control strategies. Also, it can partly explain the high frequency of the disease in a given location. The determinants of use selected in this study are illustrated in Figure 2.



Source : P. Tuo and D. M. Dali, 2019

Figure 2 : Determinants of the use of control strategies

3.3.1. The impact of household size on the means of malaria prevention

Housing amenities and household size are determinants of poverty. Poor households live in huts, shacks, isolated houses and communal yards. Indeed, bedrooms do not exceed three rooms for poor households and the size of a poor household is at least six people (ENV, 2015 p. 29 ; p. 43). These conditions then constitute a drag on the use of malaria control resources.

The correlation between family composition and means of malaria prevention is shown in Table 6.

Table 6 : Distribution of heads of households by household size and means of malaria prevention

Means of prevention	Household size								
	[1-5]		[6-10]		[11-15]		16 et more		
	Numb.	%	Numb.	%	Numb.	%	Numb.	%	Total
Nothing	12	36,36	12	36,36	3	9,09	6	18,18	33
Long-lasting impregnated mosquito net	172	43,65	130	32,99	51	12,94	41	10,40	394
Aerosol cans	58	48,73	45	37,81	10	8,40	6	5,04	119
Plant with repellent essence	3	100	0	0,00	0	0,00	0	0,00	3
Simple cover	7	53,84	2	15,38	2	15,38	2	15,38	13
Fan	36	43,90	24	29,26	12	14,63	10	12,19	82
Air conditioning	12	66,66	6	33,33	0	0	0	0	18
Smoke coil	41	44,08	29	31,18	9	9,67	14	15,05	93
Total	341		248		87		79		755

Source : Field surveys, 2019

Analysis of this table shows that aerosol cans (48.73%) and Long-lasting impregnated mosquito net (43.73%) are used more by households whose size is between 1 and 5 people. They are followed by those who use more smoke coils (44.08%) and fans (43.90%) whose size also varies between 1 and 5 persons. In addition, households with an average size of 8 persons make more use of aerosol cans (37.81%), Long-lasting impregnated mosquito net (32.99%), and smoke coils (31.18%). They are also among the users of fans (29.26%) and air conditioners (33.33%). These results show that households with a size between 1 and 10 persons have a higher probability of using prevention means than large households. Households with a size of between [11-15] persons have a low use of Long-lasting impregnated mosquito net (12.94%), simple blankets (15.38%), smoke coils (9.97%) and aerosol cans (8.40%). Families of 16 people or more use the smoke coil (15.05%), Long-lasting impregnated mosquito net (10.40%) and fans (10.19%). It can be seen that 72.72% of households that do not have any means of protection against the risk of contracting malaria have a household size of between 1 and 10 persons and 18.18% have a household size of 16 persons or more.

Chi-square results

The calculated chi-square (23.36) is lower than the tabular chi-square (32.67). Therefore, household size is not a determinant in the use of malaria preventive measures in Gagnoa.

3.3.2. Relationship between the number of bedrooms and malaria control strategies

The relationship between the number of rooms in the home and preventive measures is shown in Table 7.

Table 7 : Distribution of heads of households according to the number of rooms used and the means of malaria prevention

Means of prevention	**Number of pieces**										
	1		2		3		4		5 et more		
	Numb.	%	Numb.	%	Numb.	%	Numb.	%	Numb.	%	Total
Nothing	5	15,15	10	30,30	8	24,24	6	18,18	4	12,12	33
Long-lasting impregnated mosquito net	57	14,46	52	13,20	104	26,40	104	26,40	77	19,54	394
Aerosol cans	10	8,40	12	10,08	33	27,73	33	27,73	31	26,05	119
Plant with repellent essence	1	33,33	0	0,0	1	33,33	0	0,0	1	33,33	3
Simple cover	3	23,07	3	23,07	5	38,46	1	7,69	1	7,69	13
Fan	14	17,07	10	12,19	30	36,58	13	15,85	15	18,29	82
Air conditioning	0	0,00	0	0,00	3	16,67	10	55,56	5	33,33	18
Smoke coil	22	23,66	9	9,68	27	29,03	20	21,50	15	16,13	93
TOTAL	112		96		211		187		149		755

Source : Field surveys, 2019

This analysis reveals that Long-lasting impregnated mosquito net (26.4%) are used more by households living in three and four room houses. They are followed by those living in 5-room houses (19.54%) and those living in one-room houses (14.46%). Aerosol cans are the second most common means of prevention collected from households. The majority of users of this means of prevention live in three- and four-room dwellings (24.05%), followed by five-room dwellings (19.54%) and two-room dwellings (10.08%). Households that use air conditioning more to prevent malaria are found most in 4-room dwellings (55.36%) and those with more than 5 rooms (33.33%).

As for smoke coils, they are used more by households occupying 4 rooms (21.50%), one room (19.64%) and more than 5 rooms (16.13%). Regarding repellent petrol plants, users living in 1 room, 2 rooms and 5 rooms equally (33.33%). The fan is used as a means of prevention by households living in 4 rooms (36.58%), 6 rooms (18.29%) and 1 room (17.07%).

On the other hand, households that do not take any measures to prevent malaria despite the risk are found in all rooms but with a high proportion in 2 rooms (30.3%) and 3 rooms (24.24%).

Chi-square results

The calculated chi-square (49.24) is higher than the chi-square of the tables (41.34), so the number of rooms is a determining factor in the use of malaria mosquito control measures in the city of Gagnoa. The level of education is very important in protecting the family against diseases such as malaria.

3.3.3. The impact of the level of education on malaria control strategies

The level of education is an essential catalyst in the prevention system. Indeed, the level of education of a household head influences his or her probability of poverty because the poverty rate decreases as the level of education increases (ENV, 2015, p. 47). Poverty is a barrier to preventive measures. This table 8 shows the correlation between education level and means of malaria control.

Table 8 : Distribution of heads of households according to education level and means of malaria prevention

	Level of education								
Means of prevention	Aucun		Primary		Secondary		Superior		
	Numb.	%	Numb.	%	Numb.	%	Numb.	%	Total
Nothing	23	69,69	4	12,12	3	9,09	3	9,09	33
Long-lasting impregnated mosquito net	92	23,35	82	20,81	106	26,90	114	28,93	394
Aerosol cans	20	16,81	11	9,24	23	19,33	65	54,62	119
Plant with repellent essence	2	66,67	1	33,33	0	0,00	0	0,00	3
simple Couver	6	46,15	5	38,46	2	15,38	0	0,00	13
Air conditioning	0	0,00	0	0,00	0	0,00	18	100,0	82
Fan	18	21,95	18	21,95	31	37,84	15	18,29	18
Smoke coil	31	33,33	29	31,18	30	32,26	3	3,23	93
Total	192		150		195		218		755

Source : Field surveys, 2019

From this table, we can see that the heads of households who use aerosol cans more have a higher education level (54.62%) and secondary level (19.33%). As for Long-lasting impregnated mosquito net, they are used more by heads of households with higher education (28.93%) and those with secondary education (26.90%). 20.81% of heads of households with primary education and 23.35% of those with no education also use them to prevent malaria. Smoke coils (33.33%) are used more by uneducated household heads. This is followed by 32.26% of those with secondary education and 31.18% of those with primary education. For fan users, 37.84% have a secondary level of education and 21.95% equally for those with a primary level of education and the uneducated. Air-conditioning (100%) is more used by households with higher education. The use of simple cover is frequent among heads of households with primary education (66.66%) and those with no education (33.33%).

On the other hand, 69.69% of heads of households with no education and 12.12% of those with primary education do not use any means of prevention.

Chi-square results

The calculated chi-square (171.70) is higher than the chi-square of the tables (41.34), so the level of education is a determinant in the use of means of control against malaria. The level of education thus appears to be an essential catalyst in the household malaria prevention system.

3.3.4. The impact of income on malaria control strategies

The income of the head of the household is a crucial element in the application of malaria control strategies. Indeed, the level of socio-economic well-being measures the ability of a household to provide for the needs of the people living in it. The correlation between the monthly income of the head of household and the means of protection is seen in Table 9.

Table 9 : Distribution of heads of households according to income and means of malaria prevention

Means of prevention	Income of the head of the household (in thousand FCFA)														
	- 50		[50-100 [		[100-150[		[150-200 [		[200-250[		[250-300[		350 et more		
	Numb.	%	Numb.	%	Numb.	%	Numb.	%	Numb.	%	Numb.	%	Numb.	%	Total
Nothing	18	54,54	6	18,18	6	18,18	1	3,03	0	0,00	1	3,03	1	3,03	33
Long-lasting impregnated mosquito net	92	23,35	86	21,82	48	12,18	25	6,34	21	5,33	24	6,09	98	24,87	394
Aerosol cans	13	10,92	15	12,60	12	10,08	4	3,36	8	6,72	5	4,20	62	52,10	119
Plant with repellent essence	3	100	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	03
Simple Couver	6	45,15	3	23,08	2	15,38	2	15,38	0	0,00	0	0,00	0	0 ,00	13
Fan	22	26,83	26	31,71	7	8,54	5	6,10	4	4,87	4	4,87	14	17,07	82
Air conditioning	0	0 ,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	18	100	18
Smoke coil	36	38,71	29	31,18	11	11,83	7	7,53	7	7,53	2	2,15	1	1,08	93
Total	190		165		86		44		40		36		194		755

Source : Field surveys, 2019

This table shows that aerosol cans (52.10%) and Long-lasting impregnated mosquito net (24.87%) are used more by heads of households with an average monthly income of CFAF 350,000 and above. Next, households with an average monthly income of less than CFAF 50,000 and those with an income of between CFAF 50,000 and CFAF 100,000 use Long-lasting impregnated mosquito net at 23.35% and aerosol cans at 12.60% respectively.

Air conditioning is used 100% by wealthy households with incomes of CFAF 350,000 and above. Smoke coils are used by low-income households. Indeed, 38.71% of heads of households with an income of less than 50,000 FCFA and 31.18% of those with an income between 50,000 and 100,000 FCFA use smoke coils to prevent malaria. The use of fans as a means of prevention is not negligible. Heads of households with an income of less than 50,000 CFA francs and those with an income of between 50,000 and 100,000 CFA francs use it at 26.83% and 31.71% respectively. As for repellent plants, 100% of them are used by households with a monthly income of less than 50,000 CFA francs. The use of simple blankets (45.45%) is common in low-income households (less than 50,000 FCFA) and 23.08% of those with an income between 50,000 and 100,000 FCFA.

Furthermore, 72.72% of households that do not use any means of malaria control have less than 100,000 FCFA per month and 18.18% have an income between 100,000 and 150,000 FCFA.

Chi-square results

The calculated theoretical chi-square (184.44) is higher than the chi-square of the tables (58.12). Therefore, the monthly income of heads of households is a determinant in the use of malaria vector control methods in the town of Gagnoa. Income appears to be an important factor here. The choice of means of protection against mosquito bites within the household is generally dictated by the income of the head of household.

Of these determinants, i.e., income of the head of household, household size, housing typology, and education level, income is determined to be the variable that most affects the use of malaria prevention measures by its high Chi-square. Household income shows significant differences in the use of malaria control measures.

IV. DISCUSSION

Malaria is one of the greatest scourges that has plagued humanity for decades. It is most prevalent in Africa where a large number of people live in absolute poverty. As a result, the conditions are not in place for a proper and daily use of the preventive measures put in place by the authorities to curb this scourge. The Karl Pearson chi-square test clearly shows the impact of restricted housing on the use of malaria control measures in the town of Gagnoa. Households living in restricted habitats encounter difficulties that limit the regular use of the impregnated mosquito net. In a small house (one room), cooking utensils and food take the place of sleeping units during the day. At night, items are placed in the corners and mats spread out in the centre. The mosquito net cannot be left hanging during the day because of the risk of fire. The constraints of use do not encourage regular long-term use of the net, even if it is obtained free of charge. They discourage even the most vulnerable people (pregnant women and children under five) from protecting themselves from mosquito bites (M. K. Drabo *and al.,* 2014 p. 685) in Burkina Faso. J. M. C. Doannio *and al.* (2006, p. 50) also demonstrate that the organization of the habitat is an obstacle to the adoption and popularization of the impregnated mosquito net. This is because sleeping units are often inadequate. The nature of these units is strongly influenced by cultural specificities, but also by the socio-economic level. Large households are generally more likely to be poor.

The present study has shown that there is no close relationship between household size and the use of control methods. However, studies by J. M. C. Doannio *and al.* (2006, p. 50) and K. P. Anoh and P. Tuo (2007, p. 50) show that there is no strong relationship between household size and the use of control measures. P. Anoh and P. Tuo (2015, p. 87) in Côte d'Ivoire have shown that difficulties in using the net are also related to the number of people sharing the same sleeping unit and the technical conditions of use. The unsuitability of mats, commonly used in rural areas, is an obstacle to the protection of children who sleep there against malaria.

The level of education has a positive effect on the use of malaria control methods. The level of education is a key indicator in understanding the habitual behaviour of populations with regard to the prevention of many diseases. It influences the adoption of innovative behaviour in the understanding of health messages. In Senegal, education was cited as a key factor in net use. People who could read and write had a better knowledge of malaria than those who did not (Tall *and al.,* 2002 cited by A. N. Mabiala *and al.*, 2021, p. 8). Similarly in Congo, the mother's level of education has an influence on the use of Long-lasting impregnated mosquito net (P. M. Cilundika *and al.,* 2016 p. 3). In contrast, K. P. Anoh and P. Tuo (2015, p. 84) showed that the level of education is not a determinant of malaria control use in the Koko district in Korhogo, but the quality depends on it.

The level of socio-economic well-being is measured by the ability of a household to provide for the needs of the people living there. In a poor or low-income household, there is less access to media and information on adequate preventive methods of malaria control. In the city of Gagnoa, the income of the head of the household has an impact on the use of malaria prevention methods. In Congo, 22% of households did not own an Long-lasting impregnated mosquito net, with the most common reason given being lack of money (P. M. Cilundika *and al.*, 2016, p. 3). The issue of financial barriers is highly relevant as the poorest populations devote less financial means to prevention and therefore remain the most exposed to mosquito bites and malaria (Urugu quoted by A. P. Gogognon 2012, p. 46 ; p. 52).

This study shows that these determinants constitute an obstacle to the use of the mosquito net, which is the most recommended means of reducing morbidity and mortality caused by malaria. The precarious conditions of some households limit its daily and appropriate use.

V. CONCLUSION

Determinants such as low monthly income of the head of the household, limited housing, low level of education, influence the use of preventive means against malaria. This was confirmed by the application of the Karl Pearson Chi-2 test. Income appears to be the most influential factor in the use of means of combating the vectors of this disease. Despite the free distribution of Long-lasting impregnated mosquito net in communities to reduce malaria, these determinants are proving to be obstacles to control efforts. It is therefore essential to integrate them into policies and programmes for effective control.

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