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Research Article

Determinants of the Non-Use of Insecticide-Treated Mosquito Nets in Benin

Déterminants de la Non-Utilisation des Moustiquaires Imprégnées d'Insecticide au Bénin

Cyriaque Affoukou[1], Georgia Damien[2], Rock Yves Aïkpon[1,2], Géraud Padonou[3], William Houndjo[1], Camille Houétohossou[1], Salifou Sourakatou[1], Aurore Ogouyemi Hounto[2], Biaou Boni Olarewadjou Richard[2], Badirou Aguemon[2]

Affiliations
1. National Malaria Control Program (NMCP), Benin
2. University of Abomey-Calavi, Benin
3. Ministry of Health, Benin

Auteur correspondant
Cyriaque Affoukou
Email : moiacdm@yahoo.fr

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ABSTRACT

Introduction. The use of insecticide-treated mosquito nets (ITNs) is a key intervention in malaria control efforts. However, non-utilization of ITNs continues to be a challenge in many endemic regions, including Benin. The aim of our study was to determine the factors associated with the non-use of ITNs in Benin in 2022. **Methodology**. This study utilized secondary data from the malaria indicators survey conducted in Benin in 2022. A total of 9,184 households and 44,669 individuals were included in the analysis. The dependent variable was the non-use of ITNs, while independent variables included age, residential area, etc…. Descriptive statistics and binary logistic regression were used for data analysis. **Results.** A total of 9184 households were included in the study**.** The median age of household members was 17 years. The age group of 30-64 years was the most represented with a sex ratio of 1, 06. Household heads were predominantly of Fon ethnicity in 33% of cases, had a primary educational level in 22.7% of cases, and belonged to the middle socioeconomic status quintile in 20.8% of cases. The prevalence of non-use ITNs was 39.4%. Men slept under ITNs less than women ($p < 2.2 \times 10^{-16}$). Individuals with a primary education had a 16% lower risk of not using ITNs (aOR = 0.86; 95% CI = [0.79-0.87]) compared to those with no education. This risk was 49% lower when the household head had a secondary school (aOR = 0.51; 95% CI = [0.45-0.55]) or university education (aOR = 0. 51; 95% CI = [0.45-0.57]). **Conclusion.** Understanding and addressing the multifaceted determinants of ITN non-use are essential for improving malaria control strategies and reducing the disease burden in endemic regions like Benin.

RÉSUMÉ

Introduction. L'utilisation de moustiquaires imprégnées d'insecticide (MIIs) est une intervention clé dans les efforts de lutte contre le paludisme. Cependant, la non-utilisation des MIIs continue d'être un défi dans de nombreuses régions endémiques, dont le Bénin. L'objectif de notre étude était de déterminer les facteurs associés à la non-utilisation des MIIs au Bénin en 2022. **Méthodologie.** Cette étude a utilisé des données secondaires de l'enquête sur les indicateurs du paludisme menée au Bénin en 2022. Un total de 9 184 ménages et 44 669 sujets ont été inclus dans l'analyse. La variable dépendante était la non-utilisation des MIIs, tandis que les variables indépendantes incluaient l'âge, la zone de résidence, etc.... Des statistiques descriptives et une régression logistique binaire ont été utilisées pour l'analyse des données. **Résultats.** Un total de 9184 ménages ont été inclus dans l'étude. L'âge médian des membres du ménage était de 17 ans. Le groupe d'âge de 30 à 64 ans était le plus représenté avec un ratio hommes/femmes de 1,06. Les chefs de ménage étaient majoritairement d'ethnie Fon dans 33% des cas, avaient un niveau d'éducation primaire dans 22,7% des cas, et appartenaient au quintile de statut socio-économique moyen dans 20,8% des cas. La prévalence de la non-utilisation des MIIs était de 39,4%. Les hommes dormaient sous des MIIs moins que les femmes (p < 2,2 x 10−16). Les individus ayant un niveau d'éducation primaire avaient un risque de non-utilisation des MIIs 16% inférieur (aOR = 0,86 ; IC 95% = [0,79-0,87]) par rapport à ceux sans éducation. Ce risque était de 49% inférieur lorsque le chef de ménage avait un niveau d'éducation secondaire (aOR = 0,51 ; IC 95% = [0,45-0,55]) ou universitaire (aOR = 0,51 ; IC 95% = [0,45-0,57]). **Conclusion.** Comprendre et aborder les déterminants multifacettes de la non-utilisation des MIIs sont essentiels pour améliorer les stratégies de lutte contre le paludisme et réduire le fardeau de la maladie dans les régions endémiques comme le Bénin.

HIGHLIGHTS

What is known of the subject

The use of insecticide-treated mosquito nets (ITNs) is a key intervention in malaria control efforts.

The aim of our study

Factors associated with the non-use of ITNs in Benin in 2022.

Key Results

1. The median age of household members was 17 years. The age group of 30-64 years was the most represented and the sex ratio was 1,06.
2. Individuals with a primary education had a 16% lower risk of not using ITNs (aOR = 0.86; 95% CI = [0.79-0.87]) compared to those with no education. This risk was 49% lower when the household head had a secondary school (aOR = 0.51; 95% CI = [0.45-0.55]) or university education (aOR = 0. 51; 95% CI = [0.45-0.57]).

Implications for future practices and policies

Targeted interventions that consider demographic, socioeconomic and cultural factors are warranted to promote ITN utilization and ultimately contribute to malaria elimination efforts.

INTRODUCTION

Malaria remains a significant public health problem worldwide, especially in sub-Saharan Africa, where the burden is most pronounced **[1–4].** Malaria is caused by Plasmodium falciparum, a parasite transmitted to humans through the bites of infected mosquitoes **[5].** Globally, the number of malaria cases was estimated at 247 million in 2021, an increase of over 2 million cases compared to 2020, according to the WHO. Malaria deaths for 2021 were estimated at 619,000. Compared to 2020, there was a decrease of 28,000 deaths. The heaviest burden of malaria is recorded in the African region, with 234 million cases and 593,000 deaths in 2021 **[6].** In Benin, malaria is the leading reason for consultation in healthcare services and the primary cause of death among children under 5 years old, accounting for 49.5% of children under 5 years old with a specific death rate of 21.4% **[7].** Over the past two decades, significant investments have been made in the fight against malaria. National malaria control programs (NMCPs) exist in most malaria-endemic countries. Their mission is to ensure universal access to malaria prevention and correct treatment to reduce mortality and morbidity rates due to this disease. These programs typically organize the routine free distribution of insecticide-treated mosquito nets (ITNs) in healthcare facilities to pregnant women and children under five, who are most at risk of developing malaria infection, and depending on the periods, mass distribution campaigns of ITNs **[1].** The use of insecticide-treated mosquito nets (ITNs) by households in endemic areas significantly reduces malaria episodes and mortality associated with malaria. The use of mosquito nets is thus an indirect indicator and a useful predictor of the epidemiological impact of final health outcomes (reduction in the number of malaria cases and deaths) **[8].** This study aims to determine the factors associated with the non-use of ITNs in Benin in 2022.

PATIENTS AND METHODS

This study used secondary data from the Malaria Indicator Survey (MIS) conducted by the NMCP across the entire national territory of Benin in 2022. A total of 9184 households (5737 rural households and 3447 urban households) and 44,669 individuals who spent the night prior to the interview in the households were included in the study. The dependent variable was the non-use of ITNs the night before the survey, which was binary (Yes/No). It was coded as yes when the household member did not sleep under an ITN the night before the survey and no otherwise. The independent variables included age, residence area, department, gender of household head, educational level of household head, religion, ethnicity of household head, socioeconomic status quintile, age of ITN, and origin of ITN. Analyses were performed using SPSS 25 software. The first part of the analysis was based on descriptive statistics and the chi-square test of independence. The second part involved multivariate explanatory analysis using binary logistic regression by the stepwise (Wald) method and adjusted Odds Ratios (ORa) to measure the strength of associations. Results of different associations were considered statistically significant at $p < 0.05$.

RESULTS

All 12 departments of Benin were represented, both in urban and rural areas, with 9184 households included in the study. Nearly 71.6% of households had any type of mosquito net, and 69.4% had an ITN. The database contained a total of 42,843 individuals, and with weighting variable, we obtained a representative sample of the population, which was 46,516. Among them, 44,669 individuals, or 96.03%, had spent the night before the interview in the household. More than 6 out of 10 household members (n = 28,791; 64.5%) lived in rural areas. There was a predominance of female members with a sex ratio of 1.06. The median age of household members was 17 years (IQR: 7 years and 33 years). The youngest member was less than one month old, and the oldest was 100 years old. The age group of 30-64 years was the most represented. Household heads were predominantly of Fon ethnicity in 33% of cases, had a primary educational level in 22.7% of cases, and belonged to the middle socioeconomic status quintile in 20.8% of cases. Out of 44,669 individuals who spent the night in the household, 17,590 did not sleep under an ITN, resulting in a prevalence of ITN non-use of 39.4% with a 95% confidence interval of [38.9-39.8]. From the bivariate analysis in Table I, it is evident that ITN use differs significantly across departments ($\chi2 = 2900$; $p < 2.2 \times 10^{-16}$). Similarly, individuals living in rural areas used ITNs less than those living in urban areas ($\chi2 = 171.92$; $p < 2.2 \times 10^{-16}$). Men slept under ITNs less than women ($\chi2 = 281.37$; $p < 2.2 \times 10^{-16}$) **(Table I).** Regarding the age of household members, children under 5 years old used ITNs much more than other household members ($\chi2 = 615.45$; $p < 2.2 \times 10^{-16}$). Table I also reveals that the lower the educational level of household

heads, the less household members used ITNs (p<0.000). Additionally, household members with heads from the northern ethnicities slept under ITNs less (p < 0.000). The socioeconomic status quintile also impacted ITN use in households ($\chi 2=569.74$; $p < 2.2 \times 10^{-16}$). Table II presents the adjusted Odds Ratios related to the association of ITN use and sociodemographic characteristics. Variables associated in the bivariate analysis were retained in the final model except for the living area (**Table II).**

Table I. Distribution of household members not sleeping on ITNs by socio-demographic characteristics, 2022

Sociodemographic characteristics	N	%	No ITN use		P-value
			Oui	%	
Department					**P<0,001**
Alibori	3757	8,4	1779	47,4	
Atacora	3951	8,8	2187	55,4	
Atlantique	3693	8,3	1522	41,2	
Borgou	5517	12,4	1706	30,9	
Collines	3340	7,5	1473	44,1	
Couffo	3009	6,7	1084	36,0	
Donga	4823	10,8	2711	56,2	
Littoral	3439	7,7	683	19,9	
Mono	2921	6,5	605	20,7	
Oueme	3627	8,1	1206	33,3	
Plateau	3124	7,0	1719	55,0	
Zou	3468	7,8	915	26,4	
Place of residence					**P<0,001**
Urban	15878	35,5	5624	35,4	
Rural	28791	64,5	11966	41,6	
Gender					**P<0,001**
Male	21679	48,5	9299	42,9	
Female	22990	51,5	8291	36,1	
Age range in years					**P<0,001**
<5	8184	18,3	2355	28,8	
5-14	11931	26,7	5102	42,8	
15-29	11056	24,8	4621	41,8	
30-64	12216	27,3	4892	40,0	
65 and over	1282	2,9	620	48,4	
Household status					**P<0,001**
Spouse of head of household	6888	15,4	2228	32,3	
Head of household	8744	19,6	3526	40,3	
Son or daughter	21668	48,5	8398	38,8	
Son-in-law or daughter-in-law	743	1,7	310	41,7	
Brother or sister	1501	3,4	794	52,9	
Grandson/granddaughter	3039	6,8	1242	40,9	
Father/mother	552	1,2	329	59,6	
Parents-in-law	236	0,5	102	43,2	
Adopted/custodial	923	2,1	470	50,9	
Other	375	0,8	191	50,9	
Ethnicity of head of household					**P<0,001**
Fon and related	14722	33,0	4942	33,6	
Adja and related	6404	14,3	1838	28,7	
Yoruba and related	5425	12,1	2513	46,3	
Bariba and related	5503	12,3	2041	37,1	
Peulh and related	2681	6,0	1413	52,7	
Betamaribé and related products	3105	7,0	1603	51,6	
Yoa-lokpa and related	3491	7,8	1734	49,7	
Dendi and related	2310	5,2	1122	48,6	
Other Beninese	942	2,1	349	37,0	
Other nationality	86	0,2	35	40,7	

Table I. Distribution of household members not sleeping on ITNs by socio-demographic characteristics, 2022

Sociodemographic characteristics	N	%	No ITN use		P-value
Level of education of head of household					**P<0,001**
Not in school	23567	52,8	10747	45,6	
Primary	10121	22,7	3803	37,6	
Secondary cycle 1	5287	11,8	1624	30,7	
Secondary cycle 2	2635	5,9	640	24,3	
Superior	2159	4,8	480	22,2	
Religious school	900	2,0	296	32,9	
Marital status of head of household					**P<0,001**
Single	2057	4,6	978	47,5	
Polygamous	13590	30,4	5808	42,7	
Monogamous	25276	56,6	9197	36,4	
Widowed	3068	6,9	1323	43,1	
Divorced	678	1,5	284	41,9	
Quintile of economic well-being					**P<0,001**
The lowest	10541	23,6	4908	46,6	
Second	10074	22,6	4061	40,3	
Medium	9295	20,8	3722	40,0	
Fourth	8232	18,4	3082	37,4	
The highest	6527	14,6	1817	27,8	

Tableau I. Results of logistic regression model explaining non-use of ITN in Benin in 2022

Variables	aOR	$IC_{95\%}$ (aOR)	P-value
Department			
Zou	Reference		
Alibori	2,26	[1,95-2,61]	*0,000*
Atacora	3,10	[2,64-3,63]	*0,000*
Atlantique	2,22	[2,00-2,45]	*0,000*
Borgou	0,97	[0,84-1,12]	0,727
Collines	2,08	[1,86-2,31]	*0,000*
Couffo	1,96	[1,69-2,26]	*0,000*
Donga	4,57	[3,90-5,35]	*0,000*
Littoral	0,76	[0,66-0,85]	*0,000*
Mono	0,88	[0,76-1,00]	0,051
Ouémé	1,62	[1,46-1,79]	*0,000*
Plateau	3,02	[2,68-3,38]	*0,000*
Sex			
Female	Reference		
Male	1,30	[1,24-1,36]	*0,000*
Age range in years			
<5	Reference		
5-14	2,08	[1,95-2,21]	*0,000*
15-29	2,82	[2,61-3,02]	*0,000*
30-64	3,32	[3,01-3,64]	*0,000*
65 and over	3,98	[3,41-4,64]	*0,000*
Household status			
Spouse of head of household	Reference		
Head of household	1,22	[1,12-1,32]	*0,000*
Son or daughter	2,06	[1,89-2,24]	*0,000*
Son-in-law or daughter-in-law	1,62	[1,37-1,90]	*0,000*
Brother or sister	2,94	[2,59-3,33]	*0,000*
Grandson/granddaughter	2,59	[2,29-2,91]	*0,000*
Father/mother	2,55	[2,10-3,08]	*0,000*
Parents-in-law	1,94	[1,49-2,53]	*0,000*
Adopted/custodial	3,52	[3,01-4,11]	*0,000*
Other	3,76	[3,02-4,66]	*0,000*

Tableau II. Results of logistic regression model explaining non-use of ITN in Benin in 2022

Variables	aOR	IC95% (aOR)	P-value
Department			
Ethnicity of head of household			
Fon and related	Reference		
Adja and related	0,78	[0,70-0,86]	*0,000*
Yoruba and related	1,04	[0,96-1,12]	0,336
Bariba and related	1,01	[0,88-1,15]	0,852
Peulh and related	1,56	[1,35-1,79]	*0,000*
Betamaribé and related products	0,99	[0,84-1,14]	0,874
Yoa-lokpa and related	0,60	[0,51-0,69]	*0,000*
Dendi and related	1,01	[0,87-1,16]	0,883
Other Beninese	0,89	[0,76-1,04]	0,160
Other nationality	1,62	[1,03-2,55]	*0,035*
Education level of head of household			
Not in school	Reference		
Primary	0,84	[0,79-0,87]	*0,000*
Secondary cycle 1	0,68	[0,63-0,73]	*0,000*
Secondary cycle 2	0,51	[0,46-0,55]	*0,000*
Superior	0,51	[0,45-0,57]	*0,000*
Religious school	0,72	[0,62-0,83]	*0,000*
Marital status of head of household			
Single	Reference		
Polygamous	0,77	[0,69-0,85]	*0,000*
Monogamous	0,65	[0,59-0,71]	*0,000*
Widowed	0,64	[0,57-0,72]	*0,000*
Divorced	0,74	[0,61-0,89]	*0,001*
Quintile of economic wellbeing			
The lowest	1,10	[1,01-1,20]	*0,028*
Second	0,92	[0,84-1,01]	*0,075*
Medium	0,99	[0,91-1,08]	*0,926*
Fourth	1,03	[0,95-1,12]	*0,463*
The highest	Reference		

Compared to residents of Zou department, residents of Littoral department slept 1.32 times more under an ITN (aOR = 0.76; 95% CI = [0.66-0.85]). The risk of ITN non-use in Atacora, Donga, and Plateau departments was 3 to 4 times higher than in Zou department. Males were more likely to not use ITNs compared to females (aOR = 1.30; 95% CI = [1.24-1.36]). It was evident that age is a determinant of ITN use. There was an increasing risk of ITN non-use with the age progression of household members. Individuals with a primary education had a 16% lower risk of not using ITNs (aOR = 0.86; 95% CI = [0.79-0.87]) compared to those with no education. This risk was 49% lower when the household head had a secondary school (aOR = 0.51; 95% CI = [0.45-0.55]) or university education (aOR = 0. 51; 95% CI = [0.45-0.57]). The household socioeconomic status quintile was a determinant of ITN non-use. Households in the lowest wealth quintile (aOR = 1.10; 95% CI = [1.01-1.20]) were more at risk of not using ITNs.

DISCUSSION

The high prevalence of non-use of ITNs by household members may be linked to insufficient availability of ITNs in households. This situation could be explained by the delay in the mass distribution campaign of ITNs to the population. Indeed, the last ITN distribution campaign took place three years before the survey. It has been demonstrated that polyester net mosquito nets distributed during the last campaign lack mechanical resistance, and their physical integrity rarely lasts more than 2 to 3 years [9,10]. Non-use of ITNs by household members could also be attributed to the quality of the nets, particularly the side effects associated with the insecticides used to treat them. Several studies have reported high rates of adverse effects occurring within 24 hours after the first use of ITNs, including eye and skin irritation, and breathing difficulties **[11–13].** Accessibility to healthcare facilities (health centers, pharmacies, etc.) and information may explain why households in the Littoral department use ITNs more frequently. Indeed, the population in the Littoral region has easy access to ITNs as they can purchase them in pharmacies and from street vendors. This is not the case in remote areas of the country. The education level of the head of the household influences ITN use. Numerous studies on ITN use in sub-Saharan Africa have found similar associations between the education level of the household head and ITN use by household members **[14–16].** Eteng M et al., in a study in Cross River State, Nigeria, demonstrated that educated parents may be better able to appreciate the importance of ITNs in malaria prevention and understand the information

included in mass awareness campaigns, which impacts ITN use by household members **[17].** The association between the lowest economic wealth quintile and non-use of ITNs in households has been reported by Kasama P et al., in their study among community members at risk of malaria along the Thailand-Myanmar border **[18].** A similar finding was made in Nigeria by Russell CL et al., in a study on implications for social behavior change interventions following a mass distribution campaign of ITNs **[19].** The lack of information on malaria prevention and control methods in households with the lowest economic wealth quintile, as they lack access to television and radio, could justify this association [**8, 20].**

CONCLUSION

This study evaluates the prevalence and factors associated with non-use of ITNs in households based on data from the general population malaria indicator survey conducted in 2022. The data revealed that non-use of ITNs in households was due to several determinants, including the education level of household heads, economic wealth quintile, gender, department of residence, and marital status of the household head. Considering these factors would improve indicators for malaria control and the sustainability of these indicators towards malaria elimination.

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