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Mosquirix™ malaria vaccine: an evaluation of patients' willingness to pay in Cameroon

Defo E.T.[a,b], Tsapi A.T.[b,c], Fossi M.[d], Dongho B.D.[b,c], Nguefack-Tsague G.[e], Zogning E.M.[f,b], D.F. Achu[g], Ekobe G.E. [g], Russo G.[c], Ethgen O.[a]. Sobze M.S.[h].*

Affiliazioni:

[a]*Department of Public Health, Epidemiology and Health Economics, University of Liege, Liege, Belgium.*

[b]*Faculty of Sciences and Technology, Evangelical University of Cameroon, Bandjoun, Cameroon.*

[c]*Department of Infectious Diseases, Microbiology and Public Health; University of Rome "La Sapienza", Rome, Italy.*

[d]*Department of Medicine, University of Liege, Liege, Belgium*

[e]*Department of Public Heath, Faculty of Medicine and biomedical sciences, University of Yaoundé I, Cameroon*

[f]*Department of Experimental Medicine and surgery, "Tor Vergata" University of Rome, Rome, Italy*

[g]*National Malaria Control Program (NMCP), Ministry of Public Health, Cameroon.*

[h]*Faculty of Medicine and Pharmaceutical Sciences, University of Dschang, Dschang, Cameroon.*

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Parole chiave*: Malaria; Vaccino; Camerun; Disponibilità a pagare; Studio trasversale.*

Abstract

Objectives: The purpose of this study was to determine the average price that a patient living in Cameroon would be willing to pay for the Mosquirix™ vaccine and the factors influencing the proposed price.

Study design: Cross-sectional study

Methods: Data were collected using a semi-open questionnaire in 5 hospitals in Cameroon. This study included all persons over 18 years who came for consultation in one of the 5 selected hospitals during the study period (from 02th to 14th April 2018 and from 02th to 22th July 2018). The factors associated with the price of the vaccine proposed by the patient were determined by linear multiple regression analysis. The average price was determined based on the patient's income and the percentage of that income proposed for the purchase of the vaccine.

Results: We collected data from 1,187 participants aged 18 to 80 years. The average price that Cameroonian patients were willing to pay for the Mosquirix™ vaccine was 1,514±475 XAF (2.3±0.73 Euro). The minimum and maximum purchase price of the vaccine were 1,178 XAF (1.8 Euro) and 1,850 XAF (2.8 Euro) respectively. We also noted that patients were willing to spend an average of 1.34% of their income on the vaccine.

This percentage of income was significantly (p<0.001) associated with the respondents' income, the fact that they had been consulted at least once for malaria in the 12 months preceding the survey (p<0.001) and the fact that the respondent had at least one under-five year child (p<0.001).

Conclusion: Factors associated with the average price are elements that should be strongly considered by policy makers to introduce this vaccine in Cameroon. This pilot study can serve as a framework for a potential national population-based study.

Highlights

- Cross-sectional study on malaria
- Willingness to pay Study on vaccine
- This study is therefore a pioneering study, because to date, no studies have been conducted on the willingness to pay for the Mosquirix malaria vaccine.

Riepilogo

Obiettivi: Lo scopo di questo studio era quello di determinare il prezzo medio che un paziente che vive in Camerun sarebbe disposto a pagare per il vaccino Mosquirixtm e i fattori che influenzano il prezzo proposto.

Progettazione dello studio: studio trasversale

Metodi: I dati sono stati raccolti utilizzando un questionario semi-aperto in 5 ospedali in Camerun. Questo studio ha coinvolto tutte le persone di età superiore ai 18 anni che sono venute a consultare uno dei 5 ospedali selezionati durante il periodo di studio (dal 02 al 14 aprile 2018 e dal 02 al 22 luglio 2018). I fattori associati al prezzo del vaccino proposto dal paziente sono stati determinati da un'analisi lineare di regressione multipla. Il prezzo medio è stato determinato in base al reddito del paziente e alla percentuale di quel reddito proposto per l'acquisto del vaccino.

Risultati: Abbiamo raccolto dati da 1.187 partecipanti dai 18 agli 80 anni. Il prezzo medio che i pazienti camerunesi erano disposti a pagare per il vaccino Mosquirixtm era di 1.514 475 XAF (2,3 0,73 Euro). Il prezzo minimo e massimo di acquisto del vaccino era 1.178 XAF (1,8 Euro) e 1.850 XAF (2,8 Euro) rispettivamente. Abbiamo anche notato che i pazienti erano disposti a spendere una media di 1,34% del loro reddito sul vaccino. Questa percentuale di reddito era significativamente (P0.001) associata al reddito degli intervistati, al fatto che erano stati consultati almeno una volta per la malaria nei 12 mesi precedenti l'indagine (P0.001) e al fatto che il rispondente aveva almeno un figlio di età inferiore a cinque anni (P0.001).

Conclusione: I fattori associati al prezzo medio sono elementi che dovrebbero essere fortemente considerati dai politici per introdurre questo vaccino in Camerun. Questo studio pilota può servire da quadro per un potenziale studio nazionale basato sulla popolazione.

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Introduction

Malaria is an infectious disease caused by protozoa of the genus Plasmodium (P).1 Overall, five types of Plasmodium are likely to infect humans. Of these, P. falciparum is considered the most dangerous in terms of aggressiveness and mortality.2 Transmission occurs through bites between sunset and sunrise.3 The symptoms of human infection include fever, headache, muscle pain, chills, and vomiting.4 These symptoms can become complicated into serious syndromes and, if not adequately managed, can lead to death.5

The most affected countries in the world are in the sub-Saharan African region. Indeed, in 2017, 92% of all malaria cases recorded by the World Health Organization (WHO) were from this region.6 Cameroon is among the sub-Saharan African countries affected by malaria and among the 11 countries most affected in 2018. Cameroon is a central African country stretching from the Gulf of Guinea to Lake Chad with an area of 475,650 km^2.7 In 2018, the total population was estimated at 23,695,081 inhabitants.7 In Cameroon, malaria is the leading cause of death and morbidity among children under five years of age and pregnant women.8 In addition, malaria accounts for about 45% of household health expenditures in Cameroon.9 By 2018, of the 22,813 officially recorded deaths, 3263 (14.3%) were attributed to malaria.10 About 41% of the population has at least one malaria episode each year.11

To date, several initiatives have been taken by the World Health Organization (WHO) and the Cameroonian government to defeat the disease. These initiatives have included prevention, case management, communication, and epidemiological surveillance12. These strategies, although successful, remain insufficient. For this reason, other methods are being explored like vaccine. To date, only Mosquirix™ has demonstrate that it can significantly reduce malaria, and life-threatening severe malaria, in young African children.13 It has been approved by the European Medicines Agency (2015) and WHO has authorized pilot studies to be conducted since 2018 in 3 sub-Saharan African countries (Kenya, Malawi and Ghana) before its wider dissemination.13,14 Among children aged 5–17 months who received 4 doses of RTS,S, the vaccine prevented approximately 39% cases of malaria over 4 years of follow-up and about 29% cases of severe malaria, with significant reductions also seen in overall hospital admissions as well as in admissions due to malaria or severe anaemia.13 The malaria vaccine is proposed as a potential additional tool to complement the existing package of WHO-recommended preventive, diagnostic and treatment measures for malaria.13 Since 1975, Cameroon has adopted the WHO Expanded Program on Immunization (EPI) aimed at reducing infant mortality and morbidity by ensuring at the national level an efficient, equitable, viable vaccination system.15 So it's about making vaccines available to all children. This accessibility involves the introduction of new vaccines which are nowadays more expensive. Faced with this financial problem, Cameroon can count on the support of certain organizations, like the Global Alliance for Vaccines and Vaccination (GAVI), WHO, the United Nations Children's Fund (UNICEF), Helen Keller International (HKI), Sabine Vaccine Institute, Plan Cameroon, FICR, Rotary club and Lions Club.15 The funding for the implementation of new vaccines is therefore made through a co-funding system. (bikoy, 2013). Regarding Cameroon, its funding comes from the budget planned for the entire health system. In 2011 this funding was 504 billion FCFA.

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It is important to note that 52% came from households.16 Faced with this strong financial implication of the households, it is necessary to take into account the economic considerations of the populations before the purchase of this future vaccine, in order to hope for the widest possible dissemination and impact.

One approach that contributes to taking into account patients economic condition is the determination of willingness to pay for a good or service. Willingness to pay is defined as the maximum price that a buyer agrees to pay for a given quantity of goods or services (the "Mosquirix™" vaccine in our case).17

The aim of this study is to assess patients willingness to pay for the malaria vaccine RTS,S/AS01 (Mosquirix™) in Cameroon. This study will thus contribute to putting the patient at the heart of the decision process for the purchase of the future vaccine.

Methods

We conducted a cross-sectional study with an analytical focus, through a semi-open self-completed questionnaire in five hospitals in Cameroon. These were two hospitals located in rural areas (Dschang District Hospital and Mbouo Protestant Hospital in Bandjoun) and three hospitals located in urban areas (Odza District Medical Centre (CMA) in Yaoundé, Yaoundé Military Hospital and Efoulan District Hospital in Yaoundé). The questionnaire was structured to answer on the one hand questions concerning the socio-demographic and economic characteristics of respondents and on the other hand the propensity of patients to pay for the malaria vaccine.

Data collection took place from 02th to 14th April 2018 and 02th to 22th July 2018, based on an exhaustive sampling. This sampling concerned any person who came for consultation for problems related to malaria in one of the two hospitals mentioned above during the period of the study, aged at least 18 years, and who had given their informed consent.

The calculation of our sample size was based on following formula.18

$$n = (Z^2 * N * P(1-P)) \Big/ ((N-1) + Z^2 * P(1-P))$$

With n= sample size; Z is the approximate value of the 97.5 percentile point of the standard normal distribution=1.96; d= study precision with a margin of error (0. 05); N=the population size; the prevalence of malaria in Cameroon in 2018 was 25.8 per 100 inhabitants.10

We obtained different sample sizes for each hospital, to which we added a margin of 10% in order to account for nonresponse rate. After calculation, we obtained a minimum sample size of 1,014 people for our study. Before analysis, the data were encoded in an Excel file version 2007 and exported to SAS software (version 9.4) for analysis. Quantitative variables following a normal distribution were presented as mean ± standard deviation; and presented as median (interquartile range) otherwise. Frequencies and percentages (%) were used to describe qualitative variables. The determination of factors associated with willingness to pay (expressed as a percentage of income) was done using the multiple regression method. P-values less than 5% were considered statistically significant.

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The average proposed price for the vaccine was determined using the following formula:

$$Average\ price\ for\ the\ vaccine = \frac{1}{n}\sum_{i=1}^{n} INCi * PIPVi$$

Where *i* is the ith patient, n the total number of patients, INCi the income of patient i, and PIPVi the percentage of this income proposed for the purchase of the vaccine. The technique used for determining this willingness to pay was a direct method as information was obtained from patients using open-ended questions.[17]

Of 1,255 patients approached, 1,187 (94.6%) agreed to participate in the study. Their age ranged from 18 to 80 years with a median 24 years (IQR: 21-24 years). The participants were 53.4% women, 88.6% francophone and 65.2% from urban areas (Table 1). Of the 1187 respondents, 77.5% were single, 40.9% had at least one under-five year child and 84.1% had a household of at least 5 people (Table 1). We also noted that 11.2% of our respondents were unemployed (Table 1). In the month preceding the survey, 31.5% of patients had consulted at least once for malaria and 72.1% had used an antimalarial treatment at least once (Table 1).

III-2- Economics data

Nearly three quarters (74.9%) of the participants had an income of less than XAF 50,000 (about 76.2 euros); 89.9% reported spending less than 3,000 XAF (4.57 euros) on malaria prevention and 84.6% reported spending between 8,000 and 15,000 XAF (12.2 and 22.9 euros) on treatment during their last malaria episode (Table 2). The average willingness to pay ranged from 0% to 5% with an average of 1.34% ± 1.45

III-3- Factors associated with the willingness to pay

The analysis of all the variables that influence the participants willingness to pay concluded that, income ($p<0.001$), having at least one under-five years child ($p<0.001$) and having been consulted at least once for malaria in the 12 months preceding the survey ($p<0.001$), were significantly associated with willingness to pay (Table 3). We noted an increase in willingness to pay of 0.3% when the participant had at least one under-five years child compared to not having one. We also noted an increase in willingness to pay of 0.3% when the patient reported having been consulted at least once for malaria in the 12 months preceding the survey compared to not having been seen. Finally, we observed an increase in this availability of 1.1, 1.8, 3.5 and 3.9% when incomes were respectively in the range of 50,000-100,000 XAF (76.2-152.5 euros), 100,000-150,000 XAF (152.5-228.7 euros), 150,000-200,000 XAF (228.7-305 euros) and more than 200,000 XAF (more than 305 euros), compared to less than 50,000 XAF (76.4 euros).

III-4- Average price proposed for the vaccine

In order to determine the price at which the patient will purchase the Mosquirix vaccine, we took into consideration the income of the participants and the percentage of their income that they were willing to spend on the vaccine. The sum of the proceeds of each income multiplied by the corresponding percentage allowed us to obtain a minimum amount of 1,398,500 XAF (2,132 Euro) and a maximum of 2,196,000 XAF (3,347.8 Euro).

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From a sample of 1,187 respondents, we obtained a minimum price of 1,178 XAF (1.8 Euro) and a maximum of 1,850 XAF (2.8 Euro). Hence an average purchase price for the vaccine of 1,514 XAF (2.3 Euro).

DISCUSSION

To the best of our knowledge, no studies have been conducted on the willingness to pay for the Mosquirix malaria vaccine in Cameroon. This study is therefore a pioneering study. In this study, we collected data from 1,187 participants aged between 18 and 80 years, 49.7% of whom were women. We noted that 74.9% of the participants had a monthly income between 0 and 50,000 XAF (76.33 euros). This percentage is not surprising, especially when we learn from the fourth Cameroonian household survey (ECAM4) that in 2014, 37.5% of the population lived below the poverty line, i.e. with less than 339,715 XAF (518.60 euros) per adult and per year, or 28,310 XAF (43.2 euros) per adult and per month.19 The income percentages we obtained allowed us to determine a maximum price proposed by patients for the purchase of the "Mosquirix" vaccine of 1850 XAF (2.8 euros). This proposed price was influenced by several factors. Indeed, 3 variables: the patient's income, the fact of having at least one under-five years child, and the fact of having been at least once in consultation for malaria-related reasons during the 12 months preceding the survey; were significantly ($p<0.001$) associated with the respondents willingness to pay.

The percentage of income proposed by participants was proportional to their monthly income. That is to say, respondents with a higher income proposed a higher percentage for the purchase of the vaccine. This is not surprising given that most willingness-to-pay studies have shown that one of the main factors influencing the willingness to pay for a good or service is a person's income. These studies include the study by Dong et al.20, and the study by David et al.21

The association between the proposed percentage increase and having at least one under-five year child is due in particular to the high number of malaria cases among children in this age group. The 2018 report of the National Malaria Control Program in Cameroon mentions 2,050,944 children under 5 years of age who were seen as outpatients for malaria-related reasons;10 The report also shows that the proportion of malaria-related deaths in this age group of the population was 28.4%, making it the most vulnerable age group.

Having been hospitalized at least once in the 12 months prior to the survey for malaria appears to be an important factor influencing willingness to pay. On this point, we found that those who had consulted were more likely to offer higher income percentages than those who had not. This result could be explained by the cost of treating severe malaria. In Cameroon, the cost of managing severe malaria is 8,000 XAF (12.2 euros) for children over 5 years of age and adults. This does not include the cost of possible hospitalization and possible complications.22 In our survey, some patients mentioned expenses of up to 25,000 XAF (38.2 euros). This amount is close to the poverty line per adult per month. Exposure to such expenses leads patients to prioritise preventive methods.

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One limitation of the study is that this was hospital-based cross-sectional study which could introduce a selection bias. However, as this was a pilot study, we recommended a population-based study at the national level.

In conclusion, patients living in Cameroon were willing to spend an average of 1.34% of their income. This percentage corresponds to a price range from 1,178 XAF (1.8 euros) to 1,850 XAF (2.8 euros) with an average price of 1,514 XAF (2.3 Euro). This proposed price was significantly associated with the patient's income, the fact of having at least one under-five year's child and the fact of having been at least once in consultation for malaria-related reasons during the 12 months preceding the survey. This study is a pilot study that can serve as a framework for a potential national population-based study.

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Ethical approval

To conduct this study, we obtained the approval of the National Committee of Ethics Research for Human Health of Cameroon. Reference number: 2018/05/1025/CE/CNERSH/SP

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Conflict of interest

None declared.

Corresponding author:

Martin Sanou Sobze,
Faculty of Medicine and Pharmaceutical Sciences, University of Dschang, Dschang, Cameroon

Tel: 00237697716701 / 00393404832725;
Email: martinsobze@hotmail.com

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Appendix

Lists of tables

1. Table 1: sociodemographic Characteristics
2. Table 2: Economics characteristics
3. Table 3: Factors associated with the willingness to pay (expressed as a percentage of income

Questionnaire

Table 1: sociodemographic Characteristics (n=1187)

Characteristics	
Age (median, IQR)	*24 (21-34)*
Sex, n (%)	
Women	*597(50.3)*
Men	*590 (49.7)*
Residence area, n (%)	
Rural area	*413 (34.8)*
Urban area	*774 (65.2)*
Marital status, n (%)	
Single	*920 (77.5)*
Married	*199 (16.8)*
Cohabiting	*33 (2.8)*
Widowed	*19 (1.6)*
Divorced	*5 (0.4)*
Polygamous	*11 (0.9)*
Spoken language, n (%)	
French	*1051 (88.5)*
English	*136 (11.5)*
Highest level of study, n (%)	
Unschooled	*33 (2.8)*
Primary	*96 (8.1)*
Secondary	*278 (23.4)*

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University	*780 (65.7)*
At least 1 child under 5 years of age, n (%)	
Yes	*486 (40.9)*
No	*701 (59.1)*
At least 5 people in the household, n (%)	
Yes	*998 (84.1)*
No	*189 (15.9)*
Profession, n (%)	
Student	*666 (56.1)*
Household	*57 (4.8)*
Worker in the formal sector	*123 (10.4)*
Worker in informal sector	*208 (17.5)*
Unemployed	*133 (11.2)*
At least one malaria consultation the past month, n (%)	
Yes	*374 (31.5)*
No	*813 (68.5)*
At least one malaria consultation in the past 12 months, n (%)	
Yes	*663 (55.9)*
No	*524 (44.1)*
Recourse at least one time for treatment previous month, n (%)	
Yes	*856 (72.1)*
No	*331 (27.9)*

IQR, interquartile range

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Table 2:Economics characteristics(n=1187)

Characteristics	
Willingness to pay (expressed in% of income), (median, IQR)	*1 (0-1)*
Monthly income in XAF, n (%)	
From 0-50,000 (0-76.4 Euro)	*889 (74.9)*
From 50,000-100,000 (76.4-152.9 Euro)	*94 (7.9)*
From 100,000-150,000(152.9-229.3 Euro)	*53 (4.5)*
From 150,000-200,000(229.3-305.8 Euro)	*71 (6)*
More than 200,000 (more than 305.8 Euro)	*80 (6.7)*
Average cost of prevention in XAF, n (%)	
From 0-3000 (0-4.6 Euro)	*1067 (89.9)*
From 3000-6000 (4.6-9.2 Euro)	*109 (9.2)*
More than 6,000 (more than 9.2 Euro)	*11 (0.9)*
Treatment cost during the previous episode of malaria in XAF, n (%)	
From 0-8000 (0-12.2Euro)	*174 (14.7)*
From 8000-15,000 (12.2-22.9Euro)	*1004 (84.6)*
More than 15,000 (More than 22.9 Euro)	*9 (0.8)*

IQR, interquartile range
XAF, Central Africa CFA Franc

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Table 3: Factors associated with the willingness to pay (expressed as a percentage of income)

Significant characteristics	***Estimate***	***Standard Error***	***p-value***
Income in XAF (ref: 0-50,000 (0-76.4 Euro))			
From 50,000-100,000 (76.2-152.5 Euro)	*1.078*	*0.182*	*<0.0001*
from 100,000-150,000 (152.5-228.7 Euro)	*1.768*	*0.212*	*<0.0001*
From 150,000-200,000 (228.7-305 Euro)	*3.535*	*0.150*	*<0.0001*
More than 200,000 XAF (More than 305 Euro)	*3.871*	*0.189*	*<0.0001*
At least 1 child under 5 years of age (ref: No)			
Yes	*0.281*	*0.077*	*0.0003*
At least 1 consultation for malaria in the past 12 months (ref: No)			
Yes	*0.253*	*0.074*	*0.0007*

XAF, Central Africa CFA Franc

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QESTIONNAIRE (English version)

TITLE: **Mosquirix™ malaria vaccine: an evaluation of patients' willingness to pay in Cameroon**

Date: __/__/____ Code of the respondent:_____
____

Hospital _____ District: _____

Sociodémographics data

1. What is your place of residence?
2. Urban Rural
3. Gender : M F
4. Age:_____
5. What is your marital status:
6. Single Married Cohabiting Widow (er) Divorced Polygamous
7. What is your first language of communication?
8. French English Other (please specify) _____
9. What is your highest level of education?
10. Unschooled Primary Secondary University
11. Do you have at least one child under 5 years of age? Yes No
12. Do you have at least 5 people in your household? Yes No
13. What is your profession? _____
14. How many times in the last months have you been to the hospital for malaria consultation? _____
15. How many times in the last 12 months have you been to the hospital for malaria consultation? _____
16. Did you take treatment against malaria the previous month? Yes No

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Economics data

13. What is the average monthly income of your household?

Between 0 and 50000 CFA Franc Between 50000 and 100000 CFA Franc
Between 100000 and 150000 CFA Franc Between 150000 and 200000 CFA Franc
More than 200000 CFA Franc

14. How much does it cost to you, on average the prevention against malaria?

Between 0 and 3000 CFA Franc Between 3000 and 6000 CFA Franc
More than 6000 CFA Franc

15. How much did you spend for the treatment during your last episode of malaria?

Between 0 and 8000 CFA Franc Between 8000 and 15000 CFA Franc
More than 15000 CFA Franc

16. What percentage of your income are you willing to spend on the malaria vaccine?

_____