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Xenomonitoring as an epidemiological tool supporting post-stop surveillance of albendazole-ivermectin mass drug distribution in the Bougouni-Yanfolila evaluation unit, Sikasso, Mali, in 2023

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Abstract

Introduction Mali and Guinea share a border and are both endemic for lymphatic filariasis (LF). However, their progress towards eliminating this disease varies. Mali is currently in the LF transmission assessment survey phase (TAS), while Guinea continues to implement mass drug administration (MDA). As the populations of these two countries are closely related, and vectors are present, the emergence of LF is theoretically possible in the Bougouni-Yanfolila evaluation unit (EU). This XenoFil study, which combines xenomonitoring and serosurveillance in health facilities, was used as a surveillance tool to assess LF transmission. The aim is to detect the emergence of LF in cross-border areas within the Bougouni-Yanfolila EU, after the third LF transmission assessment survey (TAS3).

Method In the Bougouni-Yanfolila EU, we conducted a cross-sectional study to collect mosquitoes in the villages and blood samples from 6 years old and above (≥ 6 years old). In June, August 2022, and January 2023, we conducted three entomological studies in two ecologically distinct villages. The Ifakara type C tent trap (IFAKARA), the gravid trap, and indoor Pyrethrum spray catches were used to collect mosquitoes. For qPCR, mosquito of the same species was sorted into pools of twenty for molecular analysis using qPCR. The infection rate / the parasite prevalence was generated by the PoolScreen® 2 software. Trained local health workers performed serological surveys using filariasis test strips.

Results In. the two study villages, we collected a total of 4,732 mosquitoes, of which 989 belonged to the species *Anopheles gambiae s.l.* and 3,743 to species of the genus *Culex sp*. A total of 264 pools were formed, with the genus

Dr Massitan Dembele passed away but played an important role in the study and read first reports.

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Culex spp. accounted for 79.92% (211/264), while the genus *Anopheles* represented 20.08% (53/264). In June 2022, only one pool (0.53%) of *Culex spp*. tested positive [95% CI: 0.01–2.89]. Positive *Anopheles* pools were absent. The blood of ten of the 2056 individuals had positive results [0.49% (10/2056)]. Among the positives, one belonged to 6–7 years, two to that of 8–17 years, and seven to that of 18 years and older. Of the positive volunteers, 0.6% (6/996) were from Yanfolila's border health region. The average cost of XenoFil (entomology combined with serology) is 5,656,244 CFA francs (US$9070), and TAS has an average cost of 6,366,450 CFA francs (US$10209) in a survey conducted in one evaluation unit.

Conclusions The new XenoFil approach proved to be an easy, effective, and relatively cheaper method for integrated LF surveillance in rural areas. From the perspective of integrated LF monitoring, XenoFil is needed for scaling up to other EU.

Keywords Xenomonitoring, Serosurveillance, *Anopheles gambiae S.l*, *Culex spp*, *Lymphatic filariasis*, Mali, Guinea

Introduction

Lymphatic filariasis (LF), caused by *Wuchereria bancrofti* (*W. bancrofti*), is a vector-borne parasitic disease transmitted mainly in West Africa by *Anopheles gambiae s.l.* mosquitoes [1–5]. Molecular xenomonitoring (MX) is an infection surveillance method that involves gathering and examining bloodsucking insects like ticks, flies, and mosquitoes to identify any RNA or DNA associated with a pathogen or parasite that could be harmful to human or animal health [6, 7]. In the old days, we would just dissected them and looked for larvae microscopically [8].

As part of the elimination of FL, the National Program to Eliminate Lymphatic Filariasis (PNEFL) in Mali carried out a baseline mapping in 2004, revealing an overall prevalence of 7.07%, varying from 1% in the north to 18.6% in the south of the country [9]. In 2005, the mass administration of medicinal products (MA) was launched in the Bougouni-Yanfolila Evaluation Unit (UE). After completing the required number of MA cycles with a treatment coverage rate of 82%, the first LF transmission assessment survey (TAS1) was carried out in 2011 in the same unit. In the third LF Transmission Assessment Survey (TAS3) in 2019, a prevalence rate of 0.11% was observed among children aged 6 to 7 years in the Bougouni-Yanfolila EU (PNEFL, unpublished data). According to the Guinean Strategic Plan for the Control of Neglected Tropical Diseases (GSPCNTDs), the prevalence of LF fluctuated between 4.5% and 46.3% in 15 health districts between 28 February and 4 March 2005 [10]. In 2020, a mass drug administration (MDA) campaign targeting LF was implemented in 19 health districts in Guinea, a achieving a therapeutic coverage rate of at least 65% [11]. Currently, Mali is in the post-MDA surveillance phase, while Guinea is still in the implementation phase of the MDA, indicating that the two countries are not at the same level in their fight against the elimination of the LF.

The Bougouni-Yanfolila Evaluation Unit (EU) borders Côte d'Ivoire on the Bougouni and Yanfolila sides. and the same EU also borders Guinea on the Yanfolila side. The populations of Mali and Guinea maintain close relations, characterized by trade, kinship ties, rural exodus and mixed marriages. In the presence of vectors, these factors significantly increase the risk of transmission of lymphatic filariasis (LF) in border areas [12, 13]. In Although Guinea and Mali are neighbors, their respective progress in eliminating LF differs, which could lead to the emergence of new infections due to the migration of infected individuals to the EU border areas of Bougouni-Yanfolila, where AMM campaigns have been halted [13]. For LF elimination, the lack of a formal post-MDA surveillance system to rapidly detect any early resurgence (transmission hotspots) in this unit poses a high risk of resurgence in border areas of endemic countries, especially if neighboring districts are not at the same stage of LF elimination [14]. The PNEFL did not carry out a survey integrating entomological and serological techniques. The Bougouni-Yanfolila EU is a is the first where the MDA has been united, it also borders Guinea. For these reasons, the Bougouni-Yanfolila EU is a priority area for the evaluation of the LF ten years after the last MA intervention with this new technique called XenoFil (xenomonitoring combined with routine serosurveillance). In addition, the availability of more sensitive and easier-to-implement qPCR techniques for xenomonitoring, could be a good tool for monitoring transmission during post-MDA surveillance [15].

In our study, we conducted a xenomonitoring using quantitative polymerase chain reaction (qPCR) to detect *W. bancrofti* DNA in mosquitoes. This approach was integrated with serological sampling, tested with filarial test strip (FTS) to detect circulating filarial antigen (CFA) in blood samples collected during routine consultations at community health centers (CScom). The objective was to update serological and entomological data on the risk and vectorial transmission of LF in Mali, while setting up a continuous surveillance system combining xenomonitoring and routine serosurveillance.

Methodology

Study settings

The Bougouni-Yanfolila EU has 64 health areas 20 in Yanfolila and 44 in Bougouni [16], each with a CScom, for a total population estimated at 1,570,979 inhabitants as of 2023 [17].

The serological surveys were carried out in 41 EU health areas, including all the 20 health areas in the Yanfolila health district (HD) and 21 within the Bougouni HD.

For the entomological survey, in the Yanfolila health district, we chose two border villages. Siradjouba located in the Kabaya health area, with a permanent stream, and Konfra in the Nièssoumala health area, with a temporary stream (Fig. 1).

Study design

This was a cross-sectional study involving one visit for the serological survey and three visits for the entomological survey.

- **Entomological surveys**

Three rounds of mosquito collection were carried out in June 2022, August 2022 and January 2023 in selected villages in the health areas.

- **Serological survey**

Between April 2022 and February 2023, FTS surveys were conducted in 41 out of the 64 health areas in the Bougouni and Yanfolila evaluation unit (UE).

Study population

- For entomological study: mosquitoes from the *Culex spp.* and *Anopheles gambiae s.l.* were specifically targeted in the villages of Konfra and Siradjouba.
- For the serology study: we included all participants aged six and above who visited health centers in the 41 health areas selected for the study.

Sampling and sample size

Three mosquito capture techniques were used during these entomological surveys, the Ifakara type C tent trap

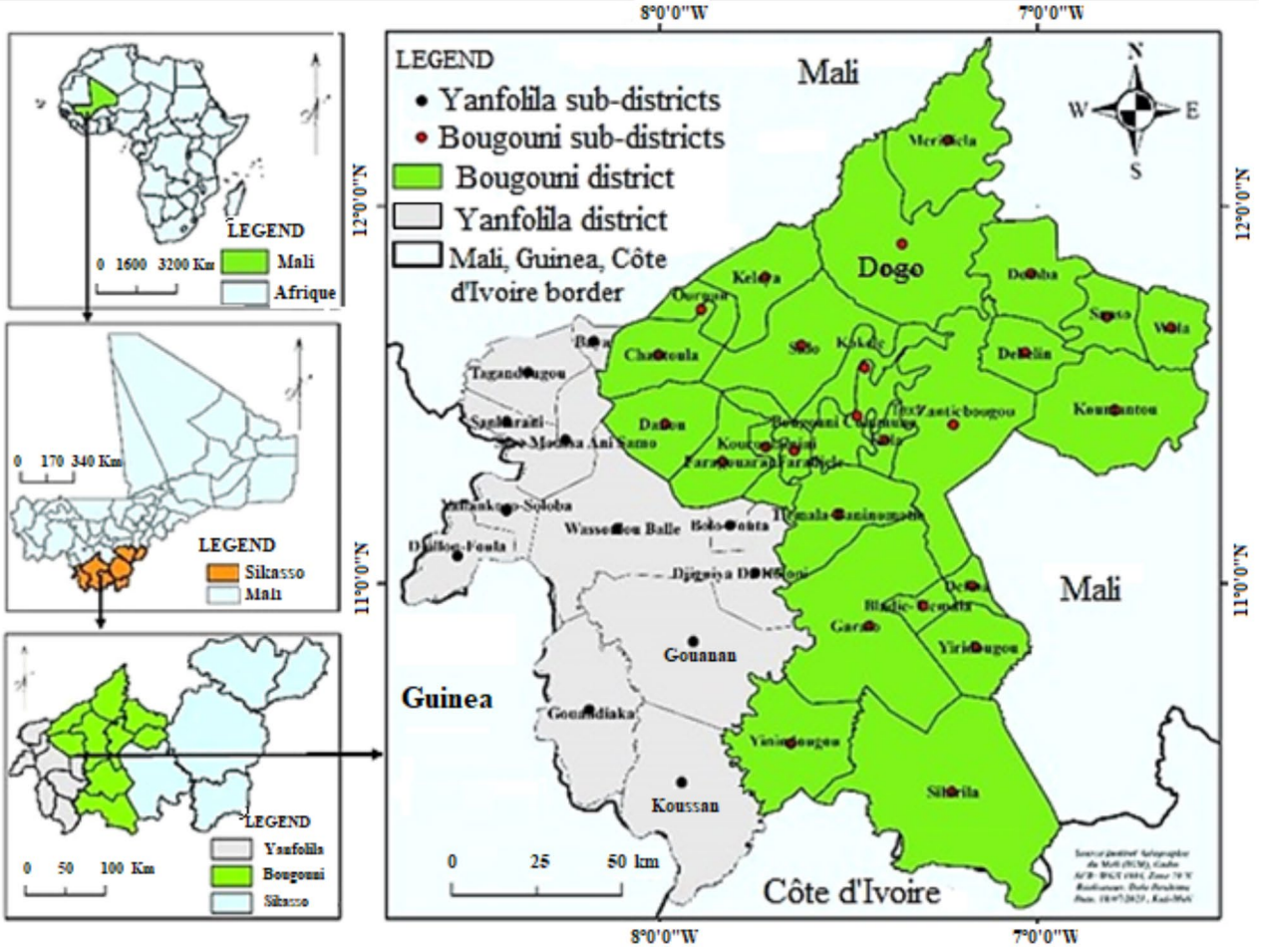

Fig. 1 Map showing study sites in the Bougouni-Yanfolila Evaluation Unit

(IFAKARA), the gravity trap and indoor Pyrethrum spray catches (PSC). We chose different collection points for these traps. For PSC, we asked the village relay to select 30 inhabited huts whose owners were volunteers. At the end of the collection, we collected a total of 4732 including 3743 *culex ssp.* and 989 *Anopheles gambiae s.l.*

For the FTS survey, we surveyed 41 health areas, including the 20 health areas of Yanfolila (the district closest to the Malian border with Guinea) and 21 health areas of Bougouni. Study subjects were recruited as they arrived at the health centers on a first-come, first-served basis during the study period. A total of 2056 volunteers constituted the size of our sample at the end of the collection period.

Data collection

Entomological data collection

Mosquito samples were collected in three passes using three capture techniques, the IFAKARA, the gravid trap and PSC [18–22]. These three techniques were used simultaneously in the two study villages. For each collection session, the gravid traps and IFAKARA were used from 6 pm to 6 am. They were placed at different points in each of the two villages. The numbers of mosquitoes collected were recorded on collection sheets per village, per trap and per replication (Additional file 1). At the end of each collection session, PSC was carried out in 30 human dwelling huts in both villages during the day before 6pm. The numbers of mosquitoes collected were recorded on collection sheets by village, by house and by replication (Additional file 2).

After each capture, the insects were sorted by trap, by village, into the genera *Anopheles gambiae s.l.*, *Culex spp* and other insects.

The female mosquitoes collected were stored in groups in 1.5 ml Eppendorf® tubes containing 70% alcohol, labelled with the identification number (ID) of the house, village and health areas as well as the date of collection and the method used. The number of mosquitoes per pool did not exceed 20. Mosquitoes remaining from two different traps or houses were not pooled together. The remaining mosquitoes from each trap or house constituted 1 pool. Consequently, the number of mosquitoes per pool varied between 2 and 20.

In addition, the geographical coordinates of all mosquito collection sites were carefully recorded.

Serological data collection

The 41 Center technical directors (CTDs) and their Immunization agent (EPI) were trained to use the FTS on blood samples to test volunteers in the CScom. CTDs and EPI agents hired tested an average of 50 people from different villages with the FTS. In addition, essential sociodemographic information such as age, sex, marital status, village, health area and district were collected using survey forms (Additional file 2).

Sample processing in the laboratory

Molecular Xenomonitoring (MX) using qPCR for processing captured mosquitoes was used in this study. All mosquitoes stored at -80 degrees were thawed and processed by the qPCR technique as described by Subramanian et al. in 2020 and Kothandan et al. in 2017 [23, 24]. The qPCR consists in amplifying a DNA or RNA fragment (complementary DNA (cDNA)) by exponential and controlled duplication [25]. This key technology relies on fluorescence to detect and quantify nucleic acid amplification products, and its homogeneous assay format has transformed legacy polymerase chain reaction (PCR) from a low-throughput qualitative gel-based technique to a frequently automated, rapid, high-throughput quantitative technology [26, 27].

Data analysis

SPSS (Statistical Package for Social Sciences) version 25 was used for data analysis. Fisher's exact test was used to compare proportions. Any p-value ≥ 0.05 was considered statistically insignificant. Variation in the prevalence of *W. bancrofti* antigen carriage was analyzed as a function of age and health areas.

The following entomological parameters were determined: vector fauna composition, monthly variations in vector density, and probability of vector infection with 95% confidence intervals. The probability of infection was estimated using PoolScreen® 2 software, kindly provided by Thomas Unnasch [28]. Collected mosquitoes' probabilities of infection were combined with FTS data to calculate the level of endemicity and the risk of transmission reappearance, and then compared with data from the same EU obtained three years ago as part of the last LF TAS.

Results

Entomological results

A total of 4732 female mosquitoes were collected during the study, including 989 *Anopheles gambiae s.l.* and 3743 specimens of *Culex spp* (Table 1). Of the 989 female *Anopheles gambiae s.l.*, 904 (91.41%) were collected in Konfra and 85 (8.59%) in Siradjouba. However, of 3743 female *Culex spp*. mosquitoes, 1368 (36.55%) were caught in Konfra and 2375 (63.45%) in Siradjouba (Table 1). No infection was recorded among *Anopheles* mosquitoes (Table 2). Of the 190 pools of *Culex spp.* mosquitoes collected in the two study villages, only one pool was found to be positive. This result came from the 120 pools of *Culex spp*. collected at Siradjouba. The probability of infection in Siradjouba was 0.83% (1/120), with a 95% confidence interval (CI) of [0.02–4.55]. In contrast, the

Table 1 Mosquitoes species composition by health center in both Konfra and Siradjouba villages in 2023

Species	Niessoumala health areas	Kabaya health areas	Total (%)
	Konfra village *n* (%)	Siradjouba village *n* (%)	
Anopheles gambiae s.l.	904 (91.41)	85 (8.59)	**989 (100)**
Culex spp	1368 (36.55)	2375 (63.45)	**3743 (100)**
Total	**2272 (48.01)**	**2460 (51.99)**	**4732 (100)**

Table 2 Estimation of the probability of infection by *Wuchereria bancrofti* in batches of the *Anopheles gambiae S.l.* Collected in the villages of Konfra and Siradjouba in 2023

Sub-district	Niessoumala	Kabaya	Total
Village	**Konfra**	**Siradjouba**	
N mosquitoes (N Pool)	904 (46)	85 (6)	**989 (52)**
N mosquitoes/pool	[8–20]	[5–20]	**[5–20]**
N positives pools	0	0	**0**
Probability of*Wb*infection [95% CI]	**0% [0-7.70]**	**0% [0-45.93]**	**0% [0-6.85]**

N = number, *Wb* = *Wuchereria bancrofti*

Table 3 Estimation of the probability of infection by *Wuchereria bancrofti* in batches of the *Culex spp* collected in the villages of Konfra and Siradjouba in 2023

Health areas t	Niessoumala	Kabaya	Total
Village	**Konfra**	**Siradjouba**	
N mosquitoes (N Pool)	1368 (70)	2375 (120)	**3743 (190)**
N mosquitoes/pool	[4–20]	[9–20]	**[4–20]**
N positives pools	0	1	**1**
Probability of*Wb*infection [95% CI]	**0% [0.00- 5.13]**	**0.83% [0.02–4.55]**	**0.53% [0.01–2.89]**

N = number, *Wb* = *Wuchereria bancrofti*

Serological data results

Table 4 Demographic traits of the study population in the Bougouni and Yanfolila sub-districts in 2023

Health district	*N* participants	%
Bougouni	1060	51,55
Yanfolila	996	48,44
Gender		
Female	1245	60,55
Male	811	39,44
Age group		
6–7 years	141	6,85
8–17 years	558	25,14
18 years and over	1357	66,00
Total	**2056**	**100**

N = number

probability of overall infection was 0.53% (1/190), with a 95% CI of [0.01–2.89] (Table 3).

Serological results

Of the 2056 people tested, 60.55% (1245/2056) were women and 66% (1357/2056) were volunteers aged 18 and older. In the Bougouni health district, the average age of the study population was 30.12 +/- 16.2 years, while in the Yanfolila health district, it was 23.6 +/- 16.5 years (Table 4).

In the Bougouni-Yanfolila EU, out of 2056 volunteers tested with FTS for circulating *W. bancrofti* antigen in blood, the prevalence was 0.49% (10/2056). Of the 41 health areas, 2 bordering health areas in the Yanfolila health district (Kabaya and Filamana) and 3 health areas in the Bougouni health district (Koumantou, Zantiièbougou and Ouroumpana) were harboring positive volunteers (Fig. 2). Overall prevalence of lymphatic filariasis in Bougouni, which stands at 0.38% (4/1060), is lower than that observed in Yanfolila, where it reaches 0.6% (6/966). Among the cases in Yanfolila, three children under 18 years of age tested positive, including a child aged 6 to 7 years (Table 5). For the latest TAS3 carried out in 2019 by the National Program of Elimination of Lymphatic Filariasis, of 39,910 children in the targeted age group 1764 children aged 6–7 years were tested. Of these, two were positive using FTS, representing a prevalence of 0.11% (2/1764) [95% CI: 0.01–0.37] (Table 6). In 2023, of a total of 69,488 children aged 6–7 years were targeted in this XenoFil survey in the same EU, 141 were examined with 1 positive, i.e. 0.7% (1/141) [95% CI: 0.125–3.907]. The antigen carriage prevalence rates from the two surveillance methods were not significantly different (Fisher's exact test, $p = 0.41$) (Table 6).

Discussion

Between 2004 and 2005, LF elimination efforts got underway in Mali with disease mapping, which was followed by yearly MDA and monitoring to assess impact [6]. After several years of consecutive MDA campaigns with geographical coverage rates of 100% and an average therapeutic coverage rate of 68.5% (77-86%) (PNEFL data, not published), a series of LF transmission evaluation surveys (the last step before validation of LF elimination) were carried out after the required number of MDA had been achieved. In the post-elimination period, it is necessary to have surveillance approaches integrated into the health system. To test an alternative LF surveillance method, we conducted a study in a LF EU comprising the Bougouni health district, which borders Côte d'Ivoire and the Yanfolila health district, which borders Guinea. These districts were the first to initiate the MDA targeting LF using ivermectin and albendazole as part of the LF elimination program. We combined an entomological

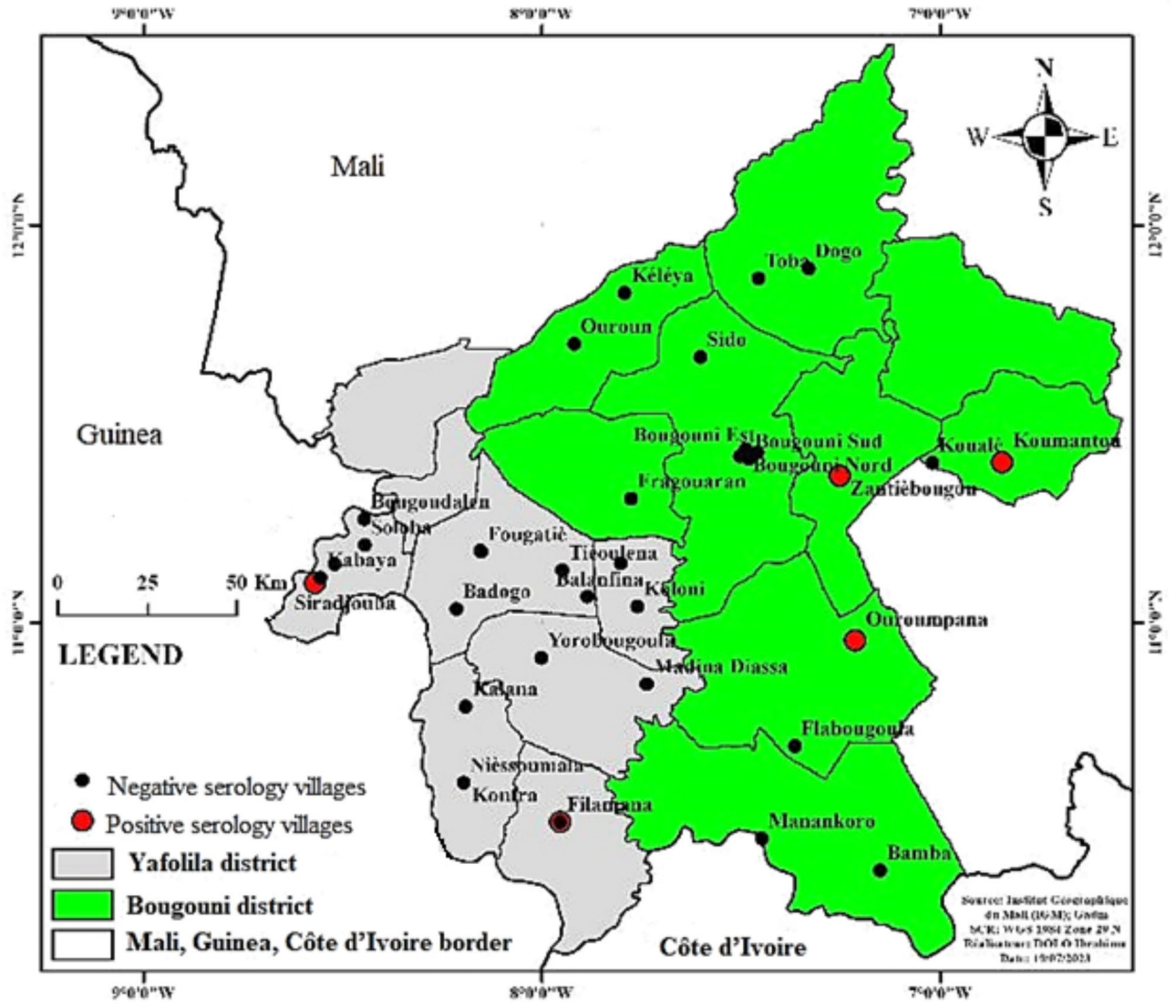

Fig. 2 Map of the Bougouni-Yanfolila Evaluation Unit showing health areas with positive and negative volunteers

Table 5 Variation in filariasis test strips Seroprevalence of *Wuchereria bancrofti* infection by age group in Bougouni and Yanfolila health districts

	Health Districts						
Age range	**BOUGOUNI**		**Bougouni Total *n* (%)**	**YANFOLILA**		**Yanfolila Total *n* (%)**	**Overall Total *n* (%)**
	***N* Negative (%)**	***N* Positive (%)**		***N* Negative (%)**	***N* Positive (%)**		
6–7 years	25(100)	0(0)	**25(100)**	115(99.1)	1(0.9)	**116(100)**	**141(100)**
8–17 years	207(100)	0(0)	**207(100)**	349(99.4)	2(0.6)	**351(100)**	**558(100)**
18 years and over	824(99.5)	4(0.5)	**828(100)**	526(98.5)	3(0.6)	**529(100)**	**1357(100)**
Total n (%)	**1056(99.62)**	**4(0.38)**	**1060(100)**	**990(99.4)**	**6(0.6)**	**996(100)**	**2056(100)**

FTS = *filariasis test strip*, N = number of volunteers

Table 6 Comparison of the results of the xenomonitoring method with those of the last TAS of the National lymphatic filariasis elimination program in the Bougouni-Yanfolila evaluation unit

Survey	Date	Test Used	Age range	Survey site	Survey method	Targeted population's size	*N* tested (% of targeted population)	*N* Positives	% positives [95% CI]
TAS3	2019	FTS	6–7 years	School	clusters	39,910	1764 (4.42%)	2	0.11 [0.01–0.37]
XenoFil	2022–2023	FTS	6–7 years	CScom	Random selection of convenience	69,488	141 (0.20%)	1	0.7% [0.125–3.907]

N = number, TAS3 = 3rd Transmission Assessment Survey, FTS = Filariasis Test Strip, Ag = Antigen, CScom = Community Health Center, XenoFil = LF xenomonitoring

approach with routine serum sample collection at community health centers in the study villages.

Monitoring with xenomonitoring

Anopheles gambiae s.l. processing using qPCR revealed no positive pools (Table 2), which is in line with the results of the last TAS3 in the same EU of Bougouni and Yanfolila where an antigenemia prevalence of 0.11% was recorded within children aged 6 to 7 years. It is recognized that with low parasite loads and in the context of the limitation phenomenon, *Anopheles* remains a less involved in the LF transmission for sustaining transmission [29]. Nevertheless, this result provides a good proxy for tracking the circulation of *W. bancrofti* within previously endemic communities. For *Culex* specimens, one pool out of 28 collected at Siradjouba was positive for *W. bancrofti* DNA, while all *Culex* pools collected at Konfra were negative for *W. bancrofti* DNA. Although it is not certain that LF is transmitted in Mali by *Culex spp* [30], there was one pool positive for *W. bancrofti* DNA. This probability of *Culex spp.* by *W. bancrofti* compared to *Anopheles* was studied by Bernard L.K et al. in 2015 in Guinea, who highlighted infection rates of *Culex* by *W. bancrofti* compared to those of *An. gambiae s.l.* infected by *W. bancrofti* [10]. However, whatever the vector is, it is important to note that the detection of *W. bancrofti* DNA in mosquitoes is a good indicator of the existence source of infection and ongoing transmission in the community [31]. The presence of parasite DNA in mosquitoes does not always mean that disease transmission is underway in the area [32]. This may be due to several factors, including the fact that parasites may be present in the mosquito without being in the transmission phase, environmental factors such as the presence of antiparasitic drugs in human blood or climatic conditions (temperature, humidity, rainfall) and facilitation and limitation phenomenon depending on the vector can also block transmission.

Based solely on the vector-parasite relationship, *Culex spp* complex members are potentially more competent for LF transmission than *Anopheles* mosquitoes, particularly when the microfilarial load is low, as would be the case after MDA [29, 33]. This may be explained by the phenomenon of limitation (decreasing yield of infective larvae per mf as the number of ingested mf increases), as in the transmission of *W. bancrofti* by *Culex* in India or by *Aedes* in Polynesia [34, 35]. In West Africa, *Anopheles gambiae s.l.* are the main vectors of LF [30]. This may be due to the lower susceptibility of *Culex spp* complex members to West African strains of *W. bancrofti* [36].

This study shows the importance of conducting post-treatment surveillance using xenomonitoring, involving communities in the collection of mosquito species disease vectors such as LF, in collaboration with reference laboratories for mosquito treatment, enabling more extensive, cost-effective surveillance to prevent the emergence of the disease so that the PNEFL can take decisions to interrupt transmission.

Serological surveillance

The blood samples collected and tested through XenoFil's activities detected a single FTS positive child. Considering children aged 6–7 years born after treatment (the age group recommended by the WHO to assess LF transmission after MDA), the infection pattern within children aged 6–7 years in this XenoFil study is like that in children aged 6–7 years in TAS3. Given the characteristics of the serological tests such as FTS, it is difficult to differentiate recent infections from old ones because people who are positive remain positive for several years [37, 38].

Despite the fact that infected individuals were found in different health areas, with the exception of 4 positives in a single health areas in the Yanfolila health district, in the different age groups, infection rates remain below the defined threshold for LF transmission by *Anopheles* species, which is 2% [39]. As a result, transmission continues in this border area, but with very low intensity. Close and sustained surveillance must be maintained throughout the border zone until Guinea meets the criteria for stopping MDA, and even after MDA has stopped in Guinea, as the disease is targeted for elimination, not eradication [40].

Wuchereria bancrofti infection prevalence Spatial variation in the Bougouni-Yanfolila EU

Of the 2056 people tested, the prevalence of filarial antigenemia was lower in Bougouni than in Yanfolila. There was no statistically significant difference between bordering and non-bordering villages regarding *W. bancrofti* FTS positive, but the six positive volunteers came from the health areas of Kabaya (including the village of Siradjouba) and Filamana, which border Guinea. This could be due in part to the fact that Guinea has not yet met the LF MDA cessation criteria yet [11].

Transmission assessment survey versus xenofil

Considering the serological results of 6–7-year-olds in the XenoFil study, we note that the prevalence rate of antigen carriage was statistically comparable to that of 6–7-year-olds in the last LF TAS carried out in 2019. Low prevalence seems to hamper statistical significance, but XenoFil has the potential to be more sensitive at detecting a signal because it covers more areas (41 villages) than TAS (30 villages). Hence the importance of implementing XenoFil in a decentralized way, integrated into the health system, where each year community drug distributors (CDDs) could randomly capture vectors using the PSC technique. Health workers in the facilities trained in the use of FTS in their CScom will oversee blood sample collection and processing in the health centers for improved and inclusive surveillance. However, this study was limited by the lack of FTS to evaluate the 64 health areas of the Bougouni-Yanfolila EU and also by the lack of financial means to carry out the entomological survey in the 8 remaining health areas of the 10 health areas bordering Guinea.

The final decision in terms of stopping transmission is similar whatever the surveillance method, as they all remain below the 2% threshold for areas where LF is transmitted by *Anopheles gambiae s.l.* [32]. It should be noted, however, that the XenoFil method, with its low implementation cost, will cover a larger geographical area and include more infected individuals than the current transmission assessment approach with the WHO TAS protocol. In addition, the xenomonitoring component of this approach enables the detection of recent infection in the vector and can be considered as a proxy for transmission through the detection of parasite DNA in mosquitoes. This implies a better performance of XenoFil in identifying potential foci of LF transmission. A survey in the village where a positive volunteer was identified would be advisable to establish the existence of a transmission focus. A scale-up of XenoFil in other EUs in the regions bordering Guinea could confirm this.

Conclusion

The new XenoFil approach has proven to be an easy and cost-effective method for integrating post-treatment surveillance for LF into the local health system in remote rural areas. From the perspective of integrated surveillance of LF, seroprevalence integrated with xenomonitoring, which involves the use of pyrethrum spraying in bedrooms to capture mosquitoes, as well as the application of qPCR to analyze these mosquitoes, to allow scale-up in other assessment units located in Guinea's border regions.

Appendix

Entomological results.

List of abbreviations

EC	Ethics Committee
CScom	Community Health Center
CTD	Center Technical Directors
EPI	Expanded Program on Immunization agent
EU	Evaluation Unit
FTS	Filariasis Test Strips
GPHC	General Population and Housing Census
GSPCNTD	Guinean Strategic Plan for the Control of Neglected Tropical Diseases
GT	Gravid Trap
HD	Health District
IFAKARA	Ifakara type C tent trap
LF	Lymphatic Filariasis
MDA	Mass Drug Administration
MX	Molecular Xenomonitoring
NPELF	National Program to Eliminate Lymphatic Filariasis
PSC	indoor Pyrethrum Spray Catches
qPCR	quantitative Polymerization Chain Reaction
TAS	Transmission assessment survey
TAS3	Third evaluation survey of the lymphatic filariasis transmissions
USTTB	University of Sciences, Techniques and Technologies of Bamako
XenoFil	xenomonitoring combined with serosurveillance healthcare centers.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-025-10733-9.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions
LS wrote this article, ID prepared the figures, HD, YIC, SYC, SSD, MS, AAD, AFD, MEC, MD, ASY and TN have all read and corrected the article.

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Data availability
The data used in this manuscript can be found through the International Center of Excellence in Research of the University of Science, Techniques and Technologies of Bamako by sending an email to the principal investigator and first author of the manuscript.

Declarations

Ethics approval and consent to participate
The Ethics Committee (EC) of the University of Sciences, Techniques and Technologies of Bamako approved the protocol under the number 2022/ 294/ EC/USTTB.
In this study, oral informed consent was administered. All people included in this study were informed verbally and clearly of the blood sampling, the risks and the benefits of the study. Only participants who voluntarily agreed to be sampled took part in the study, and no external pressure was exerted on volunteers. For all three mosquito collection methods, the team obtained verbal consent from villagers working as vector collectors with the research team, as well as from the owners of the rooms visited for mosquito collection. All participants were free to discontinue their participation at any time. In compliance with the Helsinki declaration, our protocol was submitted to and approved by an ethics committee.

Consent for publication
During the initial study visits, details of the study's objectives and implementation phases were clearly explained to the various village chiefs in a series of meetings, so that they would be informed and engaged as beneficiaries of the results, which would help the national program to improve the quality of lymphatic filariasis surveillance to rapidly detect any re-emergence of the disease in their areas bordering the country. Their verbal consent was obtained for:
- The sharing of reports with the head of the national lymphatic filariasis elimination program and the chief medical officer of the two health districts, as well as with the health managers of the health centers in the study area.
- Publication of the final report and articles with all stakeholders (from national to very peripheral levels, using appropriate media).
- Presentations of results at national and international conferences and relevant meetings to share results widely for better use and impact.

Competing interests
The authors declare no competing interests.

Clinical trial
Not applicable.

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