



Knowledge, Attitude and Practice toward Simulium Nuisances among Local Population in Guiembé, Poro Region, Côte d'Ivoire

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Authors' contributions

This work was carried out in collaboration among all authors. Author TDS drafted original manuscript. Authors YNF and KL revised the manuscript critically for important intellectual content. Author OFA involved in data acquisition, analyzed and interpreted the data. All authors read and approved the final manuscript.

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ABSTRACT

Background: Onchocerciasis (river blindness) was a major cause of blindness with significant socio-economic impacts. In endemic regions like Côte d'Ivoire, understanding community knowledge, perceptions, and behaviors is crucial for enhancing the effectiveness of preventive measures promoted by the African Programme for Onchocerciasis Control and Expanded Special Project for Elimination of Neglected Tropical Diseases (ESPEN 2016-present). This study assessed

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the knowledge, attitudes, and practices of rural populations in Guiembé toward Simulidian nuisances.

Methods: Cluster random sampling was used to select 120 adults for the study. Semi-structured questionnaires were administered to subjects. Data on knowledge of the local name, cause, mode of transmission, manifestation, severity, treatment, and prevention of onchocerciasis were collected and analysed.

Results: The studied population was predominantly male (68.3%) and had limited access to secondary education. Their primary professional activity was agriculture (84.2%). A high proportion of respondents (95.5%) reported at least one blackfly bite, primarily occurring in fields (45.8%) and near rivers (35.0%). Itching was identified as the main effect of the bites, reported by 98.3% of respondents. Grasses were perceived as the primary factor promoting the proliferation of these flies. Blackfly biting activity was more intense during the afternoon (58.3%), with a clear preference for the legs (79.2%). Regarding prevention methods, the majority of respondents (90.8%) stated they simply wore clothing for protection. In contrast, after a bite, most respondents (83.3%) took no specific measures to alleviate symptoms.

Conclusion: This study reveals a high level of exposure to black fly bites, combined with a lack of knowledge of their bioecology among residents, leading to ongoing exposure. The low uptake of post-bite curative measures highlights significant gaps in community knowledge and practice. Strengthening health education, as well as promoting preventive strategies and appropriate post-bite care, could improve the uptake and effectiveness of onchocerciasis control interventions in rural Guiembé.

Keywords: Knowledge; attitude; perception; onchocerciasis; *Simulium*; Guiembe; Côte d'Ivoire.

1. INTRODUCTION

Onchocerciasis, caused by the parasite *Onchocerca volvulus*, is among the neglected tropical diseases (NTDs) that significantly impact low-income countries (Vinkeles et al., 2021). It is transmitted through repeated bites from infected members of *Simulium damnosum* complex (black flies), which thrive in fast-flowing rivers (Weldegebreal et al., 2014). "Nine species associated with the *Simulium damnosum* complex have been identified and described taxonomically in West Africa. These include *Simulium sirbanum*, *Simulium damnosum sensu stricto*, *Simulium dieguerense*, *Simulium sanctipauli*, *Simulium soubrense*, *Simulium squamosum*, *Simulium yahense*, *Simulium leonense*, and *Simulium konkorensis* (Greenwood, 1993; Cheke et al., 2021). The first three species, commonly referred to as 'savanna flies,' serve as vectors of the savanna strain of *Onchocerca volvulus*. In contrast, the remaining species are grouped under the forest category and are responsible for transmitting the forest strain of the parasite, which is more predominantly associated with dermatological manifestations of onchocerciasis rather than the ocular pathologies leading to blindness (WHO/APOC, 1995).

The disease predominantly affects working-age individuals in rural areas of tropical and subtropical Africa. In 2015, it ranked as the

second leading infectious cause of blindness worldwide, and is a stigmatizing condition that induces severe psychological stress (WHO, 2015). As of 2017, the Global Burden of Disease Study estimated 20.9 million onchocerciasis infections, with 125 million people globally at risk—96% of them in Africa and over 99% of cases occurring in rural, riverine parts of sub-Saharan Africa (WHO, 2019).

People living or working near bodies of water, such as rivers and streams, are particularly at risk, especially those involved in agriculture, laundry, or bathing (OMS, 2017; Jacob et al., 2018). These environments provide ideal breeding grounds for blackflies, which prefer clean, fast-flowing, and oxygenated waters to lay their eggs (Greenwood, 1993). When feeding on blood, female blackflies transmit infectious L3-stage larvae, which develop into adult worms (macrofilariae) in humans. The female worms, which reside in subcutaneous nodules for up to 15 years, release a large number of microfilariae daily, triggering significant inflammatory reactions (Frallonardo et al., 2022).

Onchocerciasis causes severe complications, reducing work capacity, leading to psychological distress, and resulting in economic losses due to decreased agricultural productivity. Among the most notable symptoms are intense itching, visual impairment that can lead to blindness, and social stigmatization, which particularly affects

women by impacting their self-esteem and social interactions (Hotez et al., 2014; Noormahomed and Mascaró-Lazcano, 2019). Other consequences include reduced life expectancy, sleep disturbances, poor academic performance, a predisposition to epilepsy, and the perpetuation of poverty (Colebunders and Titulaer, 2017).

In Côte d'Ivoire, black flies have reemerged exponentially following the cessation of the onchocerciasis control program in 2002 due to the military crisis. This resurgence represents a significant nuisance, particularly in rural communities where agricultural and fishing activities dominate along fast-flowing rivers (Yapi et al., 2014; Coulibaly et al., 2022). Since 2019, a hydro-agricultural development project has been underway on the Bandama tributary in the municipality of Guiembé, aiming to irrigate several hundred hectares of agricultural land. However, such a project may also have negative impacts due to alterations in the local ecosystem, particularly through the amplification of pathogens resulting from the proliferation of disease vectors. The construction of the dam and irrigation channels has altered water flow both upstream and downstream, creating areas conducive to the breeding of blackfly larvae. These ecological changes could exacerbate the nuisance caused by blackfly vectors of onchocerciasis. In view of these challenges, it is crucial for each country to undertake entomological activities to implement vector control measures.

Raising awareness, acquiring knowledge and adopting preventive practices within communities are fundamental elements in achieving onchocerciasis elimination goals. The active participation of the local population is a guarantee of sustainability in the fight against this disease and allows the implementation of strategies tailored to the specific contexts of different regions. The elimination of onchocerciasis largely depends on improving and maintaining a high level of knowledge and appropriate preventive practices among populations living in endemic areas. This objective aims to ensure the long-term effectiveness of control and elimination strategies, while strengthening acceptable and locally adapted intervention measures (Alonso et al., 2017). The success of onchocerciasis elimination initiatives requires active and sustained community participation. Indeed, the effectiveness of control strategies depends not only on the population's in-depth understanding

of the disease, but also on their perceptions and preventive behaviours (Meribo et al., 2017).

However, as onchocerciasis incidence declines, maintaining community awareness and promoting appropriate responses becomes increasingly challenging. Misperceptions of risk may lead to reduced vigilance, thereby facilitating continued disease transmission. It is therefore essential to assess the level of awareness, perceptions and practices of local communities regarding onchocerciasis and the prevention measures implemented, particularly in areas benefiting from elimination initiatives such as mass drug administration (MDA) (Eneanya et al., 2021). Although Côte d'Ivoire remains an endemic country, data on community knowledge, perceptions and practices related to onchocerciasis control and prevention remain insufficient, highlighting the need for a thorough assessment. Thus, it is essential to assess community knowledge, risk perception, preventive practices and associated factors related to onchocerciasis in Guiembé.

2. METHODS

2.1 Study Area

The study was carried out in the commune of Guiembé (9° 14' N and 5° 43' W), located in the Poro region of northern Côte d'Ivoire, 30 km from Korhogo and around 580 km from Abidjan. It covers an area of 470 km² and has an estimated population of 19,872 (RGPH, 2021). The commune benefits from hydro-agricultural development on the Solomougou, a tributary of the Bandama river. It is bordered to the north by the sub-prefectures of Tioroniaradougou, Dassougbo and Kombolokoura, to the west by Sirasso, to the south by Dikodougou and Kiémou, and to the east by Napié (Fig. 1). The region's climate is Sudanese, with two main seasons. The dry season, which runs from November to April, precedes the rainy season, with two peaks of rainfall in August and September. Both daily and annual variations in temperature are relatively high, while humidity is lower than in the south of the country. Between December and February, the municipality is periodically exposed to the harmattan, a cool, dry wind. Annual rainfall varies between 1,000 mm and 1,400 mm.

2.2 Study Population

The study included respondents aged 15 years and over who had been continuous residents of

the community for at least six months. Purposive sampling was used for the qualitative component to ensure representation from a wide range of stakeholders.

A community-based cross-sectional study was conducted from September to October 2022 in Giembe area. A structured questionnaire was administered to consenting individuals

aged 15 years and above to assess their knowledge of blackfly bioecology and socio-economic burden of black flies. The survey covered topics such as the peak biting periods, breeding sites, effects of bites, commonly affected body parts, and preventive measures used against black fly bites. Both quantitative and qualitative data were collected from eight selected villages.

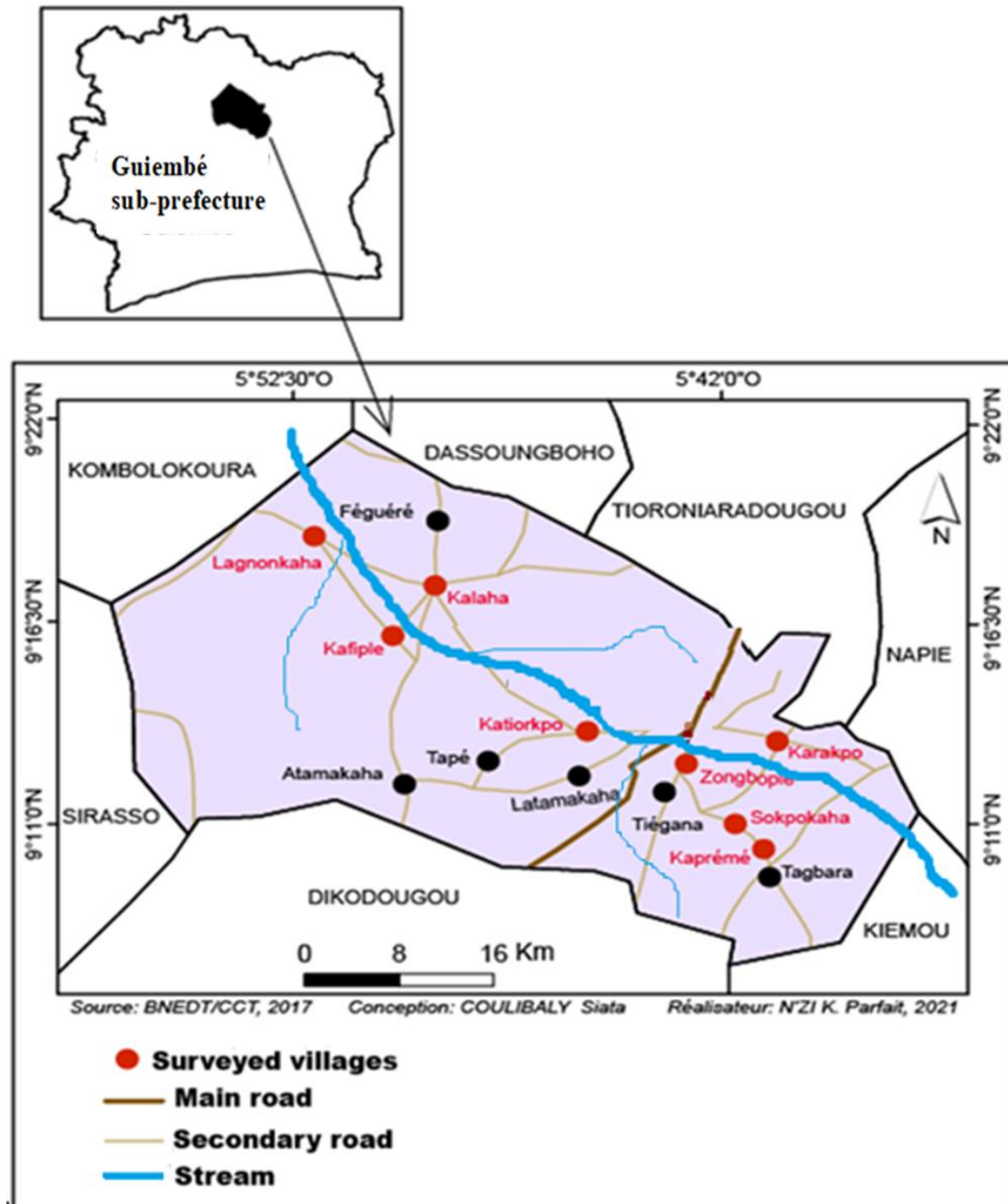


Fig. 1. Map of Guiembé showing the study sites

3. RESULTS

3.1 Socio-demographic Data of Respondents of the Community

A total of 120 individuals were interviewed. The majority of respondents were male (68.3%), and had only received a primary education (51.7%), with limited access to secondary schooling while about 36% had not received any formal education. Farming was the major occupation among the respondents (84.2%). Table 1 presents the socio-demographic characteristics of the study population, including age, gender, level of education and occupation.

3.2 Respondents' Knowledge and Perceptions on Blackfly Bioecology

The majority of respondents (95%) affirmed that they know blackflies and all reported had already been bitten. Most respondents indicated that bites were particularly intense in fields (45.8%)

and near the dam (35%), while approximately 16% reported higher biting activity at countryside. Almost all respondents identified itching (98.3%) as the primary effect of blackfly bites. The presence of grasses (56.7%) was perceived as the main source of fly proliferation, followed by the dam (19.2%) and irrigation canals (13.3%). Table 2 provides an overview of the community's knowledge and perceptions regarding the bioecology and nuisance potential of blackflies (Simuliidae).

3.3 Community Perceptions Related to Blackfly Bites

The majority of respondents (85%) reported being regularly exposed to blackfly bites. The bites were felt most intensely in the afternoon (58,3 %), and the flies bit any exposed part of the body but with affinity for the leg (79,2 %). Table 3 provides information on the population's experiences with blackfly bite.

Table 1. Sociodemographic distribution of the surveyed population by age and occupation

Age group		[15-35]	[35-50]	[50-65]	[65- ∞]	Total
		n (%)	n (%)	n (%)	n (%)	N (%)
Gender	Male	32 (39.0)	43 (52.4)	5 (6.1)	2 (2.4)	82 (68.3)
	Female	11 (29.0)	23 (60.5)	3 (7.9)	1 (2.6)	38 (31.7)
Educational Level	Primary	33 (53.2)	14 (22.6)	13 (21.0)	2 (3.2)	62 (51.7)
	Secondary	9 (60.0)	4 (26.7)	2 (13.3)	0 (0.0)	15 (12.5)
	None	13 (30.2)	12 (27.9)	7 (16.3)	11 (26.6)	43 (35.8)
Occupation	Farmer	22 (21.8)	63 (62.4)	12 (11.9)	4 (3.9)	101 (84.2)
	Trader	8 (72.7)	2 (18.8)	1 (9.1)	0 (0.0)	11 (9.6)
	Shepherd	2 (66.7)	1 (33.3)	0 (0.0)	0 (0.0)	3 (2.5)
	Pupils	5 (100)	0 (0.0)	0 (0.0)	0 (0.0)	5 (4.2)

Table I. Knowledge and attitude of respondents on bioecology of blackflies

Parameter	Response	Number of Respondent	Percentage (%)
Have you heard of blackflies ?	Yes	114	95.0
	No	6	5.0
Do you feel their bites in the population ?	Yes	120	100.0
	No	0	0.0
Where do flies bite more?	Field	55	45.8
	Countryside	19	15.8
	Riverside	42	35.0
	House	4	3.3
What are the effects of their bite ?	Itching	118	98.3
	Swelling	2	1.7
Causes of blackfly presence	Dam	23	19.2
	Irrigation canals	16	13.3
	Herbs	68	56.7
	Others	13	10.8

Table 3. Perception and knowledge of blackfly bites

Parameter	Response	Number of respondent	Percentage (%)
Bite intensity	Regularly	102	85.0
	Occasionally	14	11.7
	Rarely	4	3.3
At what time of day are their bites most intense ?	Morning	45	37.5
	Afternoon	70	58.3
	Evening	5	4.2
Which part of the body do they often bite ?	Head	6	5.0
	Neck	17	14.2
	Leg	95	79.2
	Others	2	1.7

Table 4. Knowledge of respondents on methods of prevention of blackfly bite

Parameter	Response	Number of Respondent	Percentage
Do you know about blackflies?	Yes	101	82.2
	No	19	15.8
Have you ever been informed about blackflies?	Yes	86	71.7
	No	34	28.3
How do you protect yourself against their bites ?	Clothing	109	90.8
	Rub ointement	8	6.7
	Others	3	2.5
What do you do after a bite ?	Take drugs	6	5.0
	Go to hospital	14	11.7
	Nothing	100	83.3

3.4 Community Knowledge on Blackfly Bite Prevention

The findings indicate that 82.2% of respondents are aware of blackflies, and 71.7% report having received information about them. Regarding prevention, a large majority (90.8%) prefer wearing clothing as the main personal protective measure against bites, while the use of ointments remains infrequent (6.7%). In the event of a bite, most respondents (83.3%) take no specific action, only 11.7% seek care at a health facility, and 5% resort to taking medication (Table 4).

4. DISCUSSION

The aim of this study was to assess the level of awareness, perceptions and practices of local communities in Guiembé regarding blackflies. The results revealed that respondents were characterised by a high proportion of younger farmers (90.8%) with a low level of education. The main activity was agriculture (84.2%). The data revealed a high level of awareness of blackflies among the local population, with 95%

of respondents reporting prior knowledge of the insect and having experienced bites, primarily while working in fields or near the dam. Biting was reported to occur more frequently in the afternoon and predominantly affected the lower limbs, especially the legs, resulting in itching. Respondents commonly identified grass as the main breeding site for blackflies. Notably, 83.3% of individuals reported taking no specific action following a blackfly bite.

The predominance of a young population in the agricultural sector of the study area reflects a working population that is mainly involved in agricultural work and likely to engage in outdoor activities, often near fast-flowing waterways, which are the preferred habitats of black flies of the genus *Simulium*. This exposure of the rural population, combined with low levels of education, could increase the risk of onchocerciasis transmission and limit the adoption of preventive measures essential to the elimination of the disease. These observations are consistent with findings from rural settings, where agricultural activities conducted near vector breeding sites have been associated with

increased morbidity burden (Akogun and Onwuluri, 1991, Abdullahi and Oyeyi, 2003, Kelly-Hope et al., 2015). This situation is typical of rural areas in sub-Saharan Africa and reflects structural barriers such as poverty, gender inequality and a lack of educational infrastructure. The low level of formal education observed could lead to a decline in health literacy and poor compliance with mass drug administration (MDA) campaigns, both of which are essential for eliminating onchocerciasis (Nutbeam, 2000).

The majority of respondents (95.5%) reported being familiar with blackflies and indicated that they had previously been bitten, primarily in agricultural fields and near water bodies. This high level of human-vector contact suggests a high vector density in the study area, probably linked to ecological conditions favourable to the reproduction of *Simulium* spp., such as the proximity of fast-flowing or developed watercourses (Jacob et al., 2013, Otabil et al., 2020). This corresponds to the typical breeding habitats of *Simulium* spp. and confirms their nuisance role in rural areas. The biting nuisance, frequently criticized by local populations, may lead to reduced or interrupted farming activities, potentially resulting in decreased productivity. These findings are consistent with previous studies conducted in other parts of Africa, particularly in Nigeria, where similar impacts of black fly nuisance on agricultural productivity have been documented (Amazigo, 1993; Adeleke et al., 2010).

Local perceptions of areas with high blackfly exposure sites mainly refer to fields (45.8%) and riverside (35%), which correspond to the typical ecological habitats of *Simulium* spp., whose larval development requires well-oxygenated running water (Sitarz et al., 2022, Cunze et al., 2024). This concordance between community observations and entomological data highlights a certain accuracy in the perception of exposure risk. Similar results have been reported in the Bafia health district in Cameroon, where riverside localities had higher vector densities, thus increasing the risk of onchocerciasis transmission (Domche et al., 2023). These convergences between local knowledge and scientific knowledge could be a relevant lever for strengthening community adherence to control interventions.

Almost all respondents (98.3%) identified itching as the main effect of blackfly bites, which is a typical symptom reported in several studies

addressing the nuisance caused by these vectors (Katabarwa et al., 2013, Domche et al., 2021). While this cutaneous reaction is generally benign, it can nonetheless result in considerable discomfort and negatively impact the productivity of affected populations (Sitarz et al., 2022, Siewe Fodjo et al., 2024).

Regarding perceived factors contributing to blackfly proliferation, participants most frequently cited the presence of grasses, as well as dams and irrigation canals. Although these perceptions do not fully align with the actual ecological requirements of the vector, particularly the need for fast-flowing water for larval development, they reflect a partial local understanding of habitats favorable to blackfly. (Greenwood, 1993, Cunze et al., 2024). Similar observations have been documented in Cameroon, where communities identified trees, bushes, or dense vegetation as breeding sites for blackflies (Siewe Fodjo et al., 2024). This limited knowledge of larval habitats highlights the importance of integrating local perceptions into educational outreach, in order to optimize behavior, change communication strategies and enhance the effectiveness of vector control interventions (WHO, 2025).

During this study, grasses were most commonly cited as factors contributing to the proliferation of blackflies. Although this perception does not align with the actual larval development requirements, which are primarily associated with fast-flowing water, it reflects a local knowledge that should be considered in the design of community awareness strategies (Jacob et al., 2018, Cunze et al., 2024). Respondents' perceptions revealed a partial understanding of blackfly breeding sites: while 19.2% identified dams and 13.3% irrigation canals, both consistent with known *Simulium* spp. habitats, the majority (56.7%) attributed the presence of black flies to grasses. This misconception highlights the need for targeted health education to address local misunderstandings regarding vector biology. Similar erroneous perceptions were documented in the Ntui health district, where community members believed that black flies emerged from trees and bushes (Siewe Fodjo et al., 2024).

Community perceptions gathered during this study revealed significant nuisance caused by black fly bites, particularly during daylight hours. This observation is consistent with the known behavioural patterns of black flies, whose activity can peak once or twice a day, particularly in the morning and late afternoon, depending on local

ecological conditions (Opoku, 2006, Adeleke et al., 2010, Serge et al., 2025). These peak periods often coincide with times of human activity, such as agricultural work, thereby could increase the risk of exposure, as previously reported in several endemic settings, including Nigeria (Busari et al., 2021) and Ghana (Biritwum et al., 2021). However, our results revealed an intensification of bites in the early afternoon, which contrasts with the results obtained in southwestern Nigeria, where peak bites were observed in the middle of the day (Busari et al., 2021). Despite the spatial and temporal variations observed, the diurnal nature of black fly bites is a major factor disrupting daily productive activities. Unlike mosquitoes of the genus *Anopheles*, which are mainly active at night (Spitzen et al., 2025), blackflies are active during the day, with peaks of aggressiveness often recorded in the morning and late afternoon (Serge et al., 2025). This daytime nuisance directly interferes with working hours, particularly in rural areas where agricultural and fishing activities take place outdoors. Several studies have shown that this entomological pressure can lead to a decline in productivity, temporary abandonment of arable land, and even seasonal population displacement (Coulibaly et al., 2022). These socio-economic impacts highlight the importance of integrating the behavioural dimension of vectors into control strategies, particularly through individual protection measures adapted to the activity schedules of black flies.

Furthermore, although bites have been reported on all exposed parts of the body, a marked affinity for the legs was mentioned by 79.2% of participants. These results are consistent with those obtained in previous studies, which showed that black flies tend to fly at low altitudes and preferentially land on the lower limbs, particularly in people who are standing (Greenwood, 1993). This preference could be explained by several factors, including skin temperature, proximity to the ground, or CO₂ emissions from the feet (Atekem et al., 2024). These observations highlight the relevance of targeted personal protection measures (long clothing, localised repellents) and the need to raise awareness among populations about periods of peak vector activity.

These results highlight the importance of cross-referencing objective entomological data with community perceptions in order to better understand the real impact of black flies in

endemic areas. The partial concordance between local knowledge and scientific data, particularly with regard to places and times of exposure, can be a valuable lever for designing appropriate and culturally rooted communication strategies. Furthermore, the high level of nuisance reported during working hours suggests significant repercussions on livelihoods, particularly in rural communities that are heavily dependent on agriculture. This disruption of productive activities could affect not only local food security, but also the adherence of populations to public health interventions, particularly mass treatment campaigns.

Community knowledge about blackfly bite prevention seems relatively high in the study area. Most respondents reported being familiar with blackflies and indicated that had previously received information about them. While this level of awareness is encouraging, it doesn't necessarily result in the adoption of diverse or effective preventive practices. The majority of participants (90.8%) indicated wearing clothing as the main individual protection measure, while other means, such as the use of repellent ointments, were rarely mentioned (6.7%). This reliance on clothing as the primary means of protection reflects a limited range of preventive strategies. It may be shaped by socioeconomic constraints, cultural factors or by a lack of detailed information on other available protection methods. These findings are consistent with those reported in Cameroon and the Democratic Republic of Congo, which showed that communities exposed to black fly nuisance also favour wearing protective clothing due to a lack of access to or knowledge of repellents or other means of protection (Katabarwa et al., 2013, Siewe Fodjo et al., 2024; Kamtsap et al., 2025). Furthermore, in Uganda, intensive awareness campaigns have led to a significant improvement in the adoption of complementary preventive measures, including the use of natural repellents and impregnated mosquito nets in certain riverside areas (Jacob et al., 2018), although their effectiveness against black flies remains limited (Post et al., 2011).

Furthermore, the absence of post-exposure reactions among a majority of respondents suggests a trivialization of bites or a lack of awareness of complications (inflammatory or dermatological reactions, secondary lesions, etc.). This behavior could also reflect a lack of awareness of post-bite care and the need to consult in the event of atypical symptoms (Otabil

et al., 2019). Similar observations have been reported in other endemic contexts, where limited access to care and local beliefs reduce the use of care after exposure to vectors (Busari et al., 2022, WHO, 2025).

These findings underline the need to reinforce behavior-change communication strategies, emphasizing not only the plurality of means of protection, but also the appropriate behaviors to adopt after exposure. The integration of participatory approaches, adapted to the local context, could improve community adherence to prevention measures and reinforce the effectiveness of entomological interventions (WHO, 2015).

5. CONCLUSION

This study revealed a high level of awareness regarding the nuisance caused by black flies in the municipality of Guiembé yet significant gaps remain in the population's understanding of blackfly ecology and the range of preventive measures adopted. Although the population generally identified the places and times of exposure to black flies, the attribution of their proliferation to vegetation and the low use of post-bite care indicates low health literacy. These findings highlight the urgent need to strengthen communication and prevention strategies through participatory, culturally appropriate approaches based on local realities. Integrating community knowledge into entomological interventions and developing accessible and acceptable protection tools appear essential to reducing vector nuisance and sustainably supporting efforts to eliminate onchocerciasis.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

CONSENT AND ETHICAL APPROVAL

All study participants were provided with full and detailed information on study procedures and objectives in their local language. Each participant verbally agreed and signed an informed consent to participate as a study volunteer. The study received approval from community leaders and district health authorities.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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