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ENTOMOLOGICAL AND EPIDEMIOLOGICAL ASSESSMENT OF *Glossina* SPECIES IN RELATION TO THE PREVALENCE OF TRYPANOSOMIASIS IN SELECTED AREA COUNCILS OF ABUJA

Wintola Haulatu UMARU[1], Ahmad Rufai MUSA[2,*], Okpanachi Martin ABDUBALA[3], Amana Gabriel UNEKWU[1], Sabdat Unoiza UMAR[1], Olubiyo Comfort KEHINDE[1], Olubiyo Gloria TAIYE[1] and Ogbe Kingsley UNEKWU[1]

[1]Department of Animal and Environmental Science, Prince Abubakar Audu University [PAAU], P.M.B. 1008, Anyigba, Kogi State, Nigeria; email: hwintola@yahoo.com; gabrielunekwuamana@gmail.com; sabdatunoyiza@gmail.com; kehinde128@yahoo.com; glotaiye2016@gmail.com; ogbekingsley90@gmail.com

[2]Department of Animal Science, Faculty of Agriculture, Federal University Gashua [FUGASHUA], P.M.B 1005 Nguru Road, Gashua, Yobe, Nigeria

[3]Department of Veterinary and Parasitology, Faculty of Veterinary Medicine, Ahmadu Bello University [ABU], Zaria, Kaduna, Nigeria; email: ramondokpanachi1966@gmaill.com

*Correspondence: msahmadrufai@gmail.com

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ABSTRACT. African trypanosomiasis remains a major constraint to livestock productivity and public health in sub-Saharan Africa. This study assessed the distribution, species composition, seasonal abundance, and trypanosome infection prevalence of *Glossina* species across six area councils of the Federal Capital Territory (FCT), Abuja, Nigeria. A cross-sectional entomological survey was conducted from January to December 2022 using 48 acetone-baited biconical traps deployed in riverine and gallery forest habitats, for a total of 132 trap-days. A total of 4,991 captured flies were morphologically identified. Of these, 2,736 were classified as teneral flies, while the remaining 2,255 non-teneral flies were dissected and examined microscopically for trypanosome infection. *Glossina palpalis* was the dominant species, accounting for 91% of the individuals, while *Glossina tachinoides* made up the remaining 9%. The abundance of tsetse flies showed marked spatial and seasonal variation, peaking during the wet

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season, with the highest total catch recorded in Abaji. Female flies (n = 2,723) were significantly more abundant than male flies (n = 2,268) (t = 2.431, p = 0.029). Of the non-teneral flies examined for the presence of *Trypanosoma* spp., 744 were found to be infected, for an overall prevalence of 33%. *Trypanosoma vivax* was the predominant species (27%), followed by *Trypanosoma congolense* (5%) and *Trypanosoma brucei* (1%). The data indicated that the prevalence of infection was higher in female flies than in males. Notably, the highest infection prevalence was in Kwali, suggesting that high vector abundance does not always correspond directly to the intensity of infection. These findings demonstrate heterogeneous vector distribution and infection patterns across the FCT and highlight the need for targeted, seasonally informed vector control, routine surveillance, and community-based interventions to reduce tsetse fly populations and trypanosome transmission.

Keywords: entomological survey; *Glossina palpalis*; trypanosomiasis; *Trypanosoma vivax*; vector distribution.

INTRODUCTION

Trypanosomiasis is a debilitating parasitic disease affecting both humans and livestock across sub-Saharan Africa. Transmitted primarily by tsetse flies (*Glossina* spp.), this disease can cause neurological disorders, spontaneous abortion, weight loss, progressive anaemia, and death if left untreated (WHO, 2022).

According to WHO, fewer than 1,000 cases of human African trypanosomiasis (HAT) are currently reported annually, reflecting significant progress in control efforts; however, the disease remains endemic in several regions and continues to pose a risk to vulnerable populations (WHO, 2022). In livestock, trypanosomiasis severely undermines productivity and agricultural development, with an estimated annual loss of over USD 4 billion (FAO, 2013).

Despite decades of control efforts, tsetse fly infestations persist, and previously cleared areas are experiencing re-infestation due to fragmented and unstable interventions (Majekodumi *et al*., 2013). Nigeria's Federal Capital Territory (FCT), including its suburban regions, has reported recurring infestations, posing a significant threat to its promising agricultural potential (FMA, 2019).

The presence of *Glossina palpalis*, a highly efficient vector of *Trypanosoma brucei gambiense*, has been associated with outbreaks of both animal trypanosomiasis and human sleeping sickness in the region (Ahmed *et al*., 2007; Maudlin *et al*., 2004). Tsetse flies are adrenotropic viviparous, hematophagous dipterans endemic to rural sub-Saharan Africa, with 11 species documented in Nigeria, all capable of transmitting *Trypanosoma* infections (Omonona *et al*., 2021). The central Nigerian savanna, characterised by well-watered, pasture-rich landscapes and native Guinea vegetation, provides an ideal habitat for *Glossina* spp. and supports extensive livestock grazing by Fulani herdsmen.

Given the ecological suitability of the region and the ongoing threat of trypanosomiasis, it is necessary to understand vector prevalence as it provides essential information to design targeted control strategies and to mitigate the impact of trypanosomiasis on public health and agricultural productivity. Despite previous surveys, there is a lack of recent, spatially resolved entomological and infection data for the FCT, particularly under current ecological and seasonal conditions, necessitating updated mapping of tsetse distribution and *Trypanosoma* prevalence to accurately inform contemporary control strategies.

Thus, this study assessed the distribution, species composition, seasonal abundance, and trypanosome infection prevalence of *Glossina* spp. in selected area councils of the FCT, Abuja, Nigeria.

MATERIALS AND METHODS

Study design and collection period

A cross-sectional entomological survey was conducted across the six area councils of the FCT: Gwagwalada, the Abuja Municipal Area Council (AMAC), Kwali, Abaji, Bwari, and Kuje (*Figure 1*). Sampling was carried out between January and December 2022 (NiMet, 2022).

Selection criteria for sampling locations

Study areas were selected based on criteria adapted from a comparable study in Uganda (Albert *et al.*, 2015). Area councils and sampling sites were chosen using ecological and epidemiological indicators, including proximity to perennial water bodies (rivers, streams, and ponds), the presence of riverine or gallery forest vegetation, evidence of livestock grazing, and locations characterised by frequent human–livestock interactions. This ensured that the selected sites reflected environments where tsetse fly populations and trypanosomiasis are most likely. The sampling intensity (48 traps and 132 trap-days) was guided by FAO recommendations for baseline surveys of riverine palpalis-group tsetse and by comparable regional entomological studies employing multiple biconical traps spaced across ecologically suitable habitats for several consecutive days (FAO, 2007).

Sample collection and trap deployment

A total of 48 biconical traps (white and blue) were deployed across the six area councils, with eight traps per council and two traps per selected village. The traps were baited with acetone to enhance the capture of *G. palpalis* and other species (Ahmed *et al*., 2018).

They were strategically placed in ecologically favourable locations, including forest fringes, riverbanks, streams, and ponds, which are frequented by both livestock and humans. Within each village, traps were spaced approximately 1–2 km apart and labelled for identification. Trap catches were collected every 5 days.

Sample handling and sex determination

Captured tsetse flies were gently immobilised by thoracic compression to prevent escape. Specimens were placed in labelled, ventilated insect collection boxes and transported to the laboratory within 24 h under cool conditions to minimise tissue degradation. Only non-teneral flies were selected for parasitological analysis, as teneral flies are not capable of harbouring trypanosome infections (Wamwiri and Changasi, 2016). All specimens collected from the traps were sorted and counted.

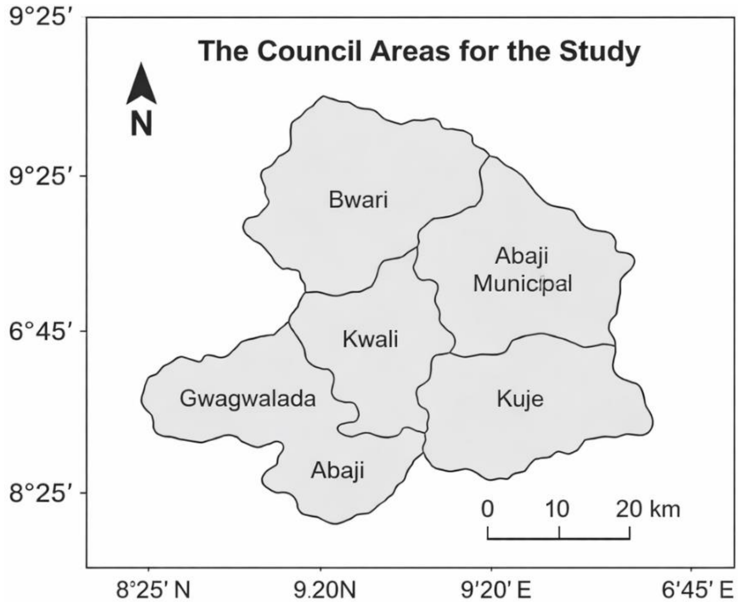

Figure 1 – A map of the selected area councils, FCT, Abuja, Nigeria

Glossina flies were identified using standard morphological keys based on external characteristics such as body size, wing venation patterns (including the characteristic hatchet cell), antennal structure, and body colouration, following established entomological identification protocols (Leak, 1999; Omonona *et al.*, 2021). The sex of each fly was determined using morphological features, particularly the presence of a hypopygium in males and an ovipositor in females, as described previously (Omonona *et al.*, 2021).

Parasitological analysis of *Trypanosoma* species

Non-teneral flies were identified by their visibly engorged abdomens. For dissection, the wings were carefully removed, and the body was placed on a slide under a dissecting microscope. The head was gently separated using a piercing needle, and the hypopharynx was extracted and placed on a clean slide with a drop of saline. Microscopic examination was performed at 320× magnification. The mid-gut and salivary glands were similarly dissected and mounted on separate slides with saline. The mouthparts (labrum and hypopharynx), mid-gut, and salivary glands were squashed and examined for *Trypanosoma* species.

Parasites were differentiated based on morphological characteristics, including size, shape, motility, and the position of the kinetoplast relative to the nucleus, following established protocols (Maudlin *et al.*, 2004).

Specifically, *Trypanosoma vivax* was identified by a small kinetoplast near the posterior end and a short undulating membrane; *Trypanosoma congolense* by a centrally located kinetoplast and intermediate undulating membrane; and *T. brucei* by a large kinetoplast positioned posterior to the nucleus and a prominent undulating membrane.

Data analysis

Data were analysed using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY, USA). Paired t-tests were used to compare male and female *Glossina* captures within the same Area Councils, with each Area Council treated as a paired observational unit. Statistical significance was set at $p < 0.05$. Descriptive statistics, including ratios and percentages, were calculated using Microsoft Excel – 2013 to summarise the distribution of flies, the infection status within the non-teneral flies, and prevalence patterns of *Trypanosoma* spp. within infected flies.

RESULTS

Distribution of *Glossina* species

As summarised in *Table 1*, across the six area councils of the FTC, 4,991 *Glossina* flies were collected over 132 trap-days. Monthly catches peaked in June, particularly in Abaji (488 flies) and Kuje (430 flies), while the lowest catch was observed in September in AMAC, with only 1 fly recorded. Fly abundance was very low during the dry season (October–April) and increased markedly during the wet season (May–September), consistent with the climatic patterns of Abuja (NiMet, 2022).

There was marked spatial variation in total fly abundance, with the highest catch recorded in Abaji (n = 1,819), followed by Kuje (n = 1,196), Bwari (n = 1,104), Kwali (n = 393), Gwagwalada (n = 290), and AMAC (n = 189).

Composition of *Glossina* species

Among the captured flies, *G. palpalis* dominated across all surveyed sites (n = 4,537), followed by *G. tachinoides* (n = 454) (*Table 2*). In AMAC, 177 *G. palpalis* and 12 *G. tachinoides* were recorded, a *G. palpalis* to *G. tachinoides* at a ratio of approximately 15:1.

There were 1,049 G. palpalis and 54 G. tachinoides recorded in Bwari, again with *G. palpalis* being more abundant. Finally, 1112 *G. palpalis* and 84 *G. tachinoides* were captured in Kuje, with *G. palpalis* being more abundant.

Sex ratio of *Glossina* species

Analysis of the demographic structure revealed a consistent female-biased sex ratio (*Table 3*). More female *Glossina* flies were captured than male flies (n = 2,723 and 2,268, respectively).

This female-biased distribution was observed across all six area councils. The difference between male and female capture ratio was significant ($t = 2.431$, $p = 0.029$). This disproportionate sex ratio, particularly evident in high-density areas like Abaji, where female captures (n = 980) exceeded male captures (n = 839) by approximately 17%, suggesting a robust and expanding breeding population.

Prevalence of *Trypanosoma* species

Of the 2,255 non-teneral *Glossina* flies examined across the six area councils, 744 were positive for *Trypanosoma* infection, with an overall prevalence of 33% (*Table 3*).

Infections occurred more often in female flies (n = 452; 60.8% of infected flies) compared with male flies (n = 292; 39.2% of infected flies). Among the area councils, the highest prevalence was recorded in Kwali (64%, corresponding to 145 out of 225 flies), followed by Bwari (32%), Abaji and AMAC (27% each), Gwagwalada (23%), and Kuje lowest (8%). Bwari had the highest number of infected flies (n = 190), followed by Kuje (n = 175), Abaji (n = 160), Kwali (n = 145), Gwagwalada (n = 51), and AMAC (n = 23).

Regarding *Trypanosoma* species distribution, *T. vivax* was the most prevalent, accounting for 608 cases, followed by *T. congolense* (n = 123 cases), while *T. brucei* was the least prevalent (n = 13 cases). The predominance of *T. vivax* was consistent across all area councils, with the highest occurrence in Bwari (n = 153 cases) and Kuje (n = 150 cases). *T. brucei* was absent in Gwagwalada and AMAC, and detected only at low frequencies in the remaining councils.

These findings indicate that *T. vivax* remains the dominant *Trypanosoma* species circulating within the study area.

Table 1 – Distribution of *Glossina* species in the six area councils of Abuja, Nigeria

Area council	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Gwagwalada	0	0	0	0	76	98	56	48	12	0	0	0	290
Kwali	0	0	0	31	109	110	51	38	10	17	0	0	393
AMAC	0	0	0	0	49	85	40	11	1	3	0	0	189
Abaji	0	0	33	168	347	488	280	161	118	103	97	8	1819
Bwari	0	0	0	134	212	373	162	115	33	44	28	3	1104
Kuje	0	0	0	142	183	430	142	101	98	54	46	0	1196
Grand total													4991

All samples were collected between January and December 2022

Table 2 – Distribution and composition of *Glossina* spp. from six area councils of Abuja, Nigeria

Area council	Non-teneral *Glossina* species	Male *Glossina* species	Female *Glossina* species	*Glossina palpalis*	*Glossina tachinoides*	Total flies collected
Gwagwalada	220	117	173	258	32	290
Kwali	225	165	228	358	35	393
AMAC	86	77	112	177	12	189
Abaji	600	839	980	1583	236	1819
Bwari	583	524	580	1049	55	1104
Kuje	541	546	650	1112	84	1196
Total	2255	2268	2723	4537	454	4991
Average	375.83	384.67	453.83	756.17	75.67	829.67

Table 3 – Prevalence of *Trypanosoma* spp. in *Glossina* spp. in the six area councils of Abuja, Nigeria

Area council	No. examined	No. positive	Approx. percentage (no. positive)	Males infected	Females infected	*Trypa-nosoma vivax*	*Trypa-nosoma congolense*	*Trypa-nosoma brucei*
Gwagwalada	220	51	23%	19	32	46	5	0
Kwali	225	145	64%	57	88	119	12	3
AMAC	86	23	27%	8	15	19	4	0
Abaji	600	160	27%	66	94	121	38	1
Bwari	583	190	32%	78	112	153	33	8
Kuje	541	175	8%	64	111	150	21	4
Total	2255	744	33%	292	452	608	123	13

DISCUSSION

Species composition and relative abundance of *Glossina* species

G. palpalis and *G. tachinoides* were the only species encountered in the riverine habitats across the six area councils of the FCT, Abuja, Nigeria. The presence of these species in this area is consistent with an earlier report that documented the occurrence of *G. palpalis* and *G. tachinoides* in the Guinea Savanna zone of Nigeria (Omonona *et al.*, 2021). The high catches of *Glossina* documented in this study may be partly attributed to the use of acetone-baited traps, which have been shown to enhance tsetse fly attraction and capture efficiency (Wamwiri and Changasi, 2016).

Previous studies have demonstrated that environmental factors such as humidity and temperature play a crucial role in the distribution and survival of *Glossina* spp. For example, high humidity levels are known to enhance tsetse fly survival, while extreme temperatures can negatively affect their activity and reproduction (Maudlin *et al.*, 2004; Wint and Rogers, 2000). Optimal temperatures between 28°C and 30°C have been reported to support *Glossina* reproduction and population stability. High humidity is known to reduce desiccation stress in tsetse flies, increasing their survival and activity. In humid conditions, tsetse flies can maintain water balance more effectively, remain active longer, and have higher capture rates in traps (Hargrove, 2004; Leak, 1999).

Therefore, the consistently high mean monthly humidity above 60% in the FCT likely contributed to the documented high abundance and successful capture of *Glossina* spp. in the study area. The spatial patterns observed in this study are consistent with established ecological drivers of *Glossina* distribution and the presence of trypanosomes in sub-Saharan Africa. The markedly higher tsetse fly abundance recorded during the wet season aligns with previous studies demonstrating that temperature and relative humidity might be the key determinants of tsetse fly survival, reproduction, and prevalence, with humid conditions reducing desiccation stress and supporting population persistence (Majekodumi *et al.*, 2013). Similarly, the concentration of flies in Abaji, Kuje, and Bwari corresponds to the presence of riverine and gallery forest vegetation, which provide stable, shaded microhabitats and maintain favourable moisture regimes even when the surrounding savanna conditions fluctuate.

Beyond environmental factors, the observed heterogeneity in infections, particularly the elevated prevalence in Kwali despite moderate fly density, may be explained by livestock movement patterns and human–animal interactions at water points and grazing interfaces, where increased host availability enhances vector–host contact and facilitates the presence of the parasite (WHO, 2022).

Together, these findings support the concept that tsetse fly prevalence and distribution are jointly shaped by climate-driven habitat suitability and host–vector interaction dynamics, rather than vector abundance alone, reinforcing the need for integrated, ecologically informed control strategies.

Sex ratio of *Glossina* species

In agreement with Ahmed *et al*. (2007), female *Glossina* catches across the six area councils of the FCT were slightly higher than male catches. Sex composition in trap catches is often influenced by the sampling method (Owaga and Challier, 1985). Traps typically capture a higher proportion of females because, depending on their reproductive state, females may travel over a wider range while searching for blood meals than males. A higher proportion of females in catches may also indicate a population experiencing nutritional stress, with nutritional deficiency potentially being more pronounced in females than males due to the viviparous nature of the species (Ahmed, 2007; Maudlin *et al.*, 2004; Molyneux and Ashford, 2004).

Given that female tsetse flies typically live longer than males and require frequent blood meals for reproduction, this demographic trend has profound implications for the sustained transmission and epidemiology of trypanosomiasis within the FCT.

Prevalence of *Trypanosoma* Species in *Glossina* species

Tsetse flies are obligate hematophagous insects that feed exclusively on the blood of vertebrate hosts. Males and females do not consume water or plant-derived fluids. They transmit protozoan parasites of the genus *Trypanosoma*, including *T. brucei* subspecies (*T. b. gambiense* and *T. b. rhodesiense*), which cause HAT, and *T. congolense* and *T. vivax*, which are primarily responsible for animal African trypanosomiasis (nagana) in livestock. Accurate trypanosome infection prevalence in both vectors and hosts could be used to predict the risk of trypanosomiasis in an area (Dagnogo *et al.*, 2004).

In the current study, the overall trypanosome prevalence in tsetse flies across the six area councils was 33%, with most infections attributed to *T. vivax*. This indicates the substantial presence of infected fly populations within the study area, although this prevalence is lower than reported by Ajuwa *et al*. (2018) (39%). The prevalence of infection was associated with vector distribution, suggesting the possibility of increased risk of trypanosome transmission to susceptible human and animal populations rather than direct evidence of disease distribution. The results showed a significantly higher proportion of female flies harbouring infections than male flies.

These findings are similar to data obtained in another study in Nigeria (Ahmed, 2007). The lower prevalence of infection in male flies could be attributed to the fact that the males take a blood meal every 3–4 days while females feed more regularly for reproductive purposes (Maudlin *et al.*, 2004). The increased feeding activity of tsetse flies enhances host–vector contact and may increase the likelihood of acquiring trypanosome infections, as feeding behaviour is a key determinant of transmission dynamics (Aksoy *et al.*, 2014).

Several factors may account for the higher prevalence of *T. vivax* and the relatively lower occurrence of *T. congolense* and *T. brucei* observed in this study. This pattern is consistent with previous studies in sub-Saharan Africa, where *T. vivax* is often reported as the predominant trypanosome species in both tsetse flies and livestock (Fetene *et al.*, 2021).

The higher prevalence of *T. vivax* may be attributed to its ability to be transmitted both cyclically by tsetse flies and mechanically by other biting flies, thereby enhancing its spread across different ecological settings (Aksoy *et al.*, 2014). In contrast, *T. congolense* and *T. brucei* rely primarily on cyclical transfer within the tsetse fly vector, which may limit their relative prevalence. Additionally, variations in host availability and parasite–vector interactions may further influence the observed infection patterns in the study area.

Limitations of the study

There are several limitations to this study. First, reliance on microscopy to identify *Trypanosoma* species can be problematic, especially in cases of mixed infections, as morphological differentiation is often unreliable. Without molecular confirmation, the prevalence of infection (33%) and apparent dominance of *T. vivax* reported in this study should be interpreted with caution. Second, the use of basic statistical tools such as t-tests to assess associations across councils, time points, sex ratios, and infection outcomes may not fully capture the complexity of the data.

More advanced methods like logistic regression or generalised linear models would offer deeper insights and enhance the accuracy of the findings. Lastly, dissection of flies only indicates that the specimen has been exposed to *Trypanosoma* spp. Therefore, prevalence alone should not be considered a direct indicator of the disease.

CONCLUSIONS

This study demonstrates a heterogeneous distribution of *Glossina* spp. and associated trypanosome infections across the FCT, Abuja, Nigeria. The highest number of catches were recorded in Abaji (n = 1819), whereas Kwali showed the highest prevalence of trypanosome infection (64%), indicating spatial heterogeneity in vector distribution and infection risk across the region. *G. palpalis* was the predominant tsetse fly species, and the abundance of tsetse flies peaked during the wet season, indicating marked seasonal variation in vector dynamics. The prevalence of infection was 33% among non-teneral flies, with *T. vivax* being the most prevalent species, followed by *T. congolense* and *T. brucei*. The higher number of female *Glossina* flies identified in the study areas may be associated with greater host contact and feeding frequency. These findings underscore the need for targeted, seasonally informed vector control strategies, supported by routine surveillance and community-based interventions, to reduce tsetse populations and trypanosome transmission in the study area.

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