

Abundance, resting and blood-meal preferences of *Aedes aegypti* in Ouagadougou, Burkina Faso

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Abstract

Burkina Faso has experienced a re-emergence of dengue in recent years, with the majority of cases occurring in Ouagadougou. Effective control of the main vector *Aedes aegypti*, during outbreaks, requires a particularly better understanding of its behaviour and ecology. The study aims to assess the abundance, resting preferences and blood meal of *Aedes aegypti* from Ouagadougou,

A total of 60 concessions in the districts of Bogodogo and Nongremasson were visited monthly from August to November 2021 for adult collection. Adults were collected indoors and outdoors. The origin of the blood meal in *Aedes aegypti* was determined by multiplex PCR targeting cytochrome b.

A total of 671 *Aedes aegypti* individuals were collected, representing 5.35% of the total mosquitoes collected. Analysis of the resting preferences revealed a highly significant asymmetrical distribution between indoor and outdoor collected mosquitoes ($p < 0.001$). Only 24.1% ($n = 162$) were collected indoors, compared with 75.9% ($n = 509$) outdoors, representing an indoor/outdoor ratio of 0.32. From the 44 samples successfully identified, human blood was the most frequent meal source, 84.1% (37/44), and 11.36% (5/44) from animals, indicating a strong anthropophilic behaviour of *Aedes aegypti* in the city of Ouagadougou. However, a proportion of mosquitoes, 4.7% had mixed blood meals, indicating trophic opportunism.

This resting and blood-feeding behaviour has important implications for disease transmission and vector control. Strategy based solely on indoor insecticide spraying may have limited effectiveness. Integrated approaches that target both outdoor and indoor resting sites and are therefore more likely to achieve a significant impact.

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Abondance, préférences en matière de repos et repas de sang de *Aedes aegypti* à Ouagadougou, au Burkina Faso

Résumé

Le Burkina Faso est confronté à une recrudescence de la dengue ces dernières années, la majorité des cas étant recensés à Ouagadougou. La lutte contre le principal vecteur, *Aedes aegypti*, nécessite une meilleure compréhension de son comportement et de son écologie. Cette étude vise à évaluer l'abondance, les préférences en matière de repos et les sources de repas sanguin de *Aedes aegypti* à Ouagadougou.

Au total, 60 concessions situées dans les arrondissements de Bogodogo et Nongremasson ont été visitées d'août à novembre 2021 pour la collecte des adultes de moustiques. Les collectes ont été effectuées à l'intérieur et à l'extérieur des habitations. L'origine des repas sanguins de *Aedes aegypti* a été déterminée par PCR multiplex ciblant le cytochrome b.

Au total, 671 individus de *Aedes aegypti* ont été collectés, représentant 5,35 % du nombre total de moustiques collectés. L'analyse des préférences en matière de repos a révélé une distribution asymétrique hautement significative entre les moustiques collectés à l'intérieur et à l'extérieur ($p < 0,001$). Seulement 24,1 % ($n = 162$) ont été collectés à l'intérieur, contre 75,9 % ($n = 509$) à l'extérieur, soit un ratio intérieur/extérieur de 0,32. Sur les 44 échantillons dont l'origine de sang a été identifiée, le sang humain était la source de repas la plus fréquente, représentant 84,1 % (37/44), et le sang animal 11,36 % (5/44), ce qui indique une anthropophilie élevée de *Aedes aegypti* dans la ville de Ouagadougou.

Ce comportement particulier en matière de repos et d'alimentation a des implications importantes pour la transmission des maladies et la lutte antivectorielle. Une stratégie basée uniquement sur la pulvérisation d'insecticides à l'intérieur des habitations pourrait avoir une efficacité limitée. Des approches intégrées ciblant à la fois les sites de repos intérieurs et extérieurs sont plus susceptibles d'avoir un impact significatif.

Mots clés : *Aedes aegypti*, comportement de repos, préférence de repas sanguin, dengue, Ouagadougou,

Introduction

Over the last decades, dengue has emerged as one of the most significant viral diseases affecting tropical and subtropical regions globally. From January 2024 to September 2025, more than 18 million of cases of 14,355 deaths were reported in the world (1). In Africa in 2023, 245,176 dengue cases were reported, causing 771 deaths (2). In Burkina, the most severe dengue outbreak occurred in 2023, with 160,751 suspected cases and 724 deaths reported. During this outbreak, more than 56 % of cases and 42% of deaths occurred in the only

Ouagadougou centre region (3). Across Africa, the burden of dengue remains poorly understood due to inadequate surveillance and limited case reporting (4). *Ae. aegypti* and *Ae. albopictus* are known as the main dengue and arboviruses vectors in West Africa (5).

The response to the dengue outbreak relies mainly on the control of adult mosquitoes, which aims to quickly reduce the adult density and minimize the transmission (6). The use of insecticides to target either indoor or outdoor resting mosquitoes requires a better understanding of the adult's behaviour. Resting behaviour is a key parameter for selecting *Aedes* control strategy as it can guide decision on whether to apply insecticides indoors, outdoors, or both.

Resting behaviour of *Ae. aegypti* is variable across the African continent (7). While in some countries such as Burkina Faso (8) and Ethiopia (9) *Ae. aegypti* has been found resting more outdoors, in Senegal, it has been found resting equally in both indoor and outdoor (10).

The blood-meal preference and anthropophilic rate have been demonstrated to be crucial parameters for mosquito borne diseases transmission (11). *Aedes aegypti* from Burkina Faso shows a preference for human blood as reported in Ouagadougou (8).

Aedes aegypti is characterised by its highly domestic behaviour and its marked preference for human hosts. Colonisation dynamics and the specific composition of *Aedes* populations may vary depending on the type of environment: densely built-up urban areas and more vegetated peri-urban areas offer distinct ecological conditions that can influence the distribution, abundance, and feeding behaviour of mosquitoes (12). These differences could have significant implications for dengue transmission, but they remain poorly documented in Burkina in the context of re-emergence of arboviral diseases. This study aims to characterise the abundance, resting preferences and blood-feeding patterns of *Aedes aegypti* from Ouagadougou.

I. Material and methods

I.1. Study sites

This study took place from August to November 2021 in the city of Ouagadougou (12° 21' 56.4" North, 1° 32' 2" West). Ouagadougou is the capital and largest city of Burkina Faso, with an estimated population of 2,780,000 (13). The town is located roughly in the centre

of the country, in the province of Kadiogo, in the inter-tropical zone. It is the administrative centre of the country. The climate is Sudano-Sahelian with an average annual rainfall of 400-800 mm (14) . The study was carried out in Nongr-Massom and Bogodogo districts. In each district, 30 households were selected for four months of survey. A total of 240 households were visited during the study.

I.2. Adult mosquito collection

Adult mosquito collection was conducted in the morning from 7:00 a.m. to 11:00 a.m., as this period is suitable for *Aedes* mosquito sampling. All areas likely to be used as resting places for mosquitoes were visited for 15 minutes. Collections were made indoors for endophilic mosquitoes and outdoors shelters for exophilic mosquitoes using a battery-operated Prokopack aspirator (15). Each month, 60 concessions were visited in both districts for 6 days and 10 households were targeted to be sampled daily. Collected mosquitoes were sorted morphologically using classical identification keys (16-18) and stored in 1.5 ml tubes (Eppendorf®) over silica gel separately according to genus, species, repletion stages (unfed, gravid, blood fed), and collection location (inside or outside housing).

I.3. Study of blood feeding preferences by molecular analysis

Full and partially blood fed *Aedes* mosquitoes were screened to identify the host species origin of their blood meal using DNA extracted from the blood meal in the mosquito abdomen. Each mosquito was dissected, and the abdomen containing the ingested blood was used for DNA extraction. DNA was extracted using DNAZOL® reagent (Invitrogen™) following the protocol described by Chomczynski *et al.* (19). A total of 58 abdomens of blood-fed or partially blood-fed females were screened for molecular blood meal identification.

The origin of the blood meal was determined by multiplex PCR, following the method of Kent and Norris, (20), which targets mitochondrial cytochrome b gene sequences. The PCR reaction mixture (final volume 12.5 µL) contained 6.25 µL of Master Mix, 2.25 µL of sterile water, 0.5 µL of each primer pair (universal, human, goat, pig, dog, and cow), and 1 µL of genomic DNA. Amplifications were carried out in a SimpliAmp™ Thermal Cycler under the following program: initial denaturation at 95 °C for 5 min (1 cycle), followed by 40 cycles of denaturation at 95 °C for 60 s, annealing at 56 °C for 60 s, and

extension at 72 °C for 60 s, with a final extension at 72 °C for 7 min, and storage at 4 °C.

PCR products (10 µL) were mixed with 2 µL of loading dye and electrophoresed on a 2 % agarose gel prepared in 1× Tris-Borate-EDTA (TBE) buffer at 120 V for 45 min. A 100 bp molecular weight marker was used to estimate fragment size. DNA bands were visualized under ultraviolet light (UV), and the host blood-meal origin was determined by comparing of the DNA migration bands with the molecular weight marker corresponding to human (334 bp), cow (561 bp), dog (680 bp), goat (132 bp) and pig (452 bp).

I.4. Data analysis

Differences between indoor and outdoor collected mosquitoes were assessed using a Chi-square test of independence to determine whether resting site distribution differed significantly from a random expectation. The indoor/outdoor ratio was computed as the proportion of mosquitoes collected indoors divided by those collected outdoors. An equal 50:50 distribution was used as a null expectation in the absence of resting preference. In addition, odds ratios (OR) with 95% confidence intervals were calculated to quantify the likelihood of *Aedes aegypti* being collected outdoors relative to indoors.

Females *Aedes aegypti* were classified by physiological condition (Unfed, Partially-fed, Fed, Gravid) and capture position (indoor or outdoor). For each condition, the proportion of mosquito collected in each position was calculated, and a proportion test (prop.test) was performed to determine whether the observed distribution differed significantly from an equal 50:50 distribution. Results were visualised using a heatmap showing the proportion of captures per condition and position. All the analyses were performed using R software version 4.5.0.

II. Results

II.1 Relative density of mosquito species collected

A total of 12,534 mosquitoes were collected during the study period, belonging to seven species (Table I). *Culex quinquefasciatus* was by far the most abundant species, accounting for 86.46% of all captures. *Anopheles gambiae s.l.* represented 8.11%, while *Aedes aegypti* contributed 5.35% of the total. The remaining species *Ae. vittatus*, *Ae. formosus*, *Ae. hirsutus*, and *Ae. metalucus*, were only sporadically

reported, with less than 0.09% of the total collected. This composition indicates a strong dominance of *Culex* species in the sampled areas, followed by a moderate presence of *Anopheles* and *Aedes* mosquitoes.

Table I: Proportion of each mosquito species collected from August to November 2021

<i>Species</i>	Number collected	Relative abundance (%)
<i>Cx. quinquefasciatus</i>	10838	86.46
<i>An. gambiae s.l.</i>	1016	8.11
<i>Ae. aegypti</i>	671	5.35
<i>Ae. vittatus</i>	4	0.03
<i>Ae. formosus</i>	2	0.02
<i>Ae. hirsutus</i>	1	0.02
<i>Ae. metalucis</i>	2	0.01
Total	12534	100

Cx: *Culex*; *An:* *Anopheles*; *Ae:* *Aedes*

II.2. Indoor and outdoor resting and blood-feeding patterns behaviour of *Aedes aegypti*

Analysis of the resting preferences of *Aedes aegypti* revealed a highly asymmetrical distribution between indoor and outdoor captures. Out of a total of 671 individuals collected, only 24.1% (n = 162) were collected indoors, compared to 75.9% (n = 509) collected outdoors (Figure 1).

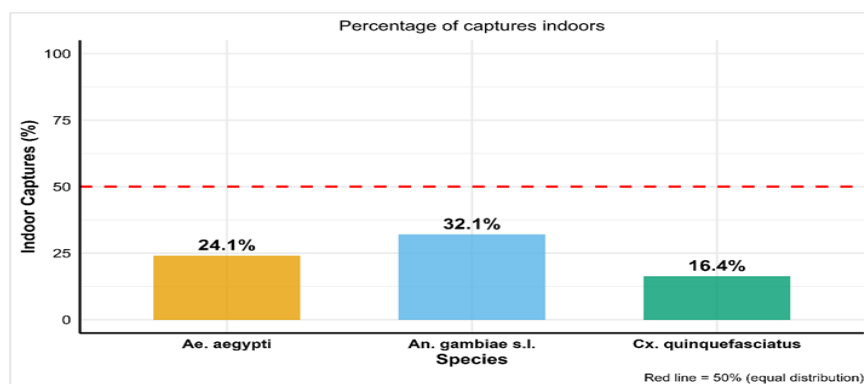


Figure 1: Proportion (%) of *Ae. aegypti*, *An. gambiae s.l.*, and *Cx. quinquefasciatus* collected indoor during the study period (August-November). The red dashed line represents the 50% threshold, indicating an equal distribution between indoor and outdoor positions. *Ae:* *Aedes*, *An:* *Anopheles*, *Cx:* *Culex*.

This difference is statistically highly significant (Chi-square test, $p < 0.001$), with an indoor/outdoor ratio of 0.32. The odds ratio suggested that mosquitoes are more likely to be collected outdoors than indoors (OR= 3.1, 95% CI: 2.4-4.1). Indoor/Outdoor ratios (OR) were found to vary according to the month. From August to October *Ae. aegypti* maintained OR < 1 , consistently favouring outdoor resting behaviour (Figure 2).

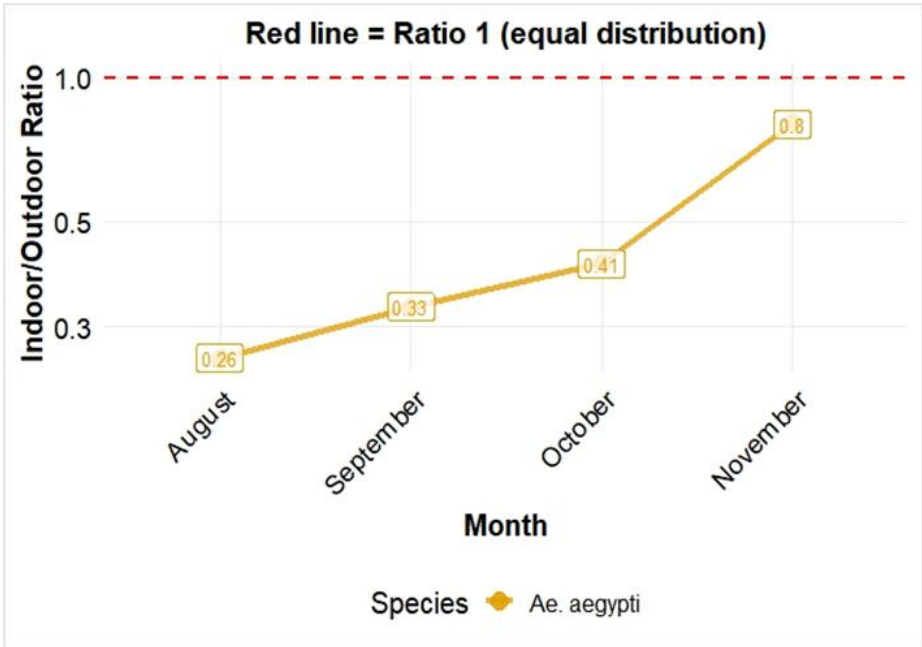


Figure 2: Monthly variation of Indoor/Outdoor ratio of *Aedes aegypti*. Temporal changes in the indoor/outdoor ratio (OR) for *Aedes aegypti*. A ratio below 1 indicates outdoor predominance, while a ratio above 1 reflects higher indoor activity.

Bogodogo consistently exhibited greater mosquito densities than Nongr-Massom, suggesting that urban microhabitats provide more favourable breeding sites. In both districts, outdoor collected mosquitoes generally exceeded indoor collected one the number of outdoor-collected mosquitoes generally exceeded that of indoor-collected ones. However, the trend to exophily was higher in Bogodogo, where greater outdoor densities throughout all months were observed (Figure 3A & 3B).

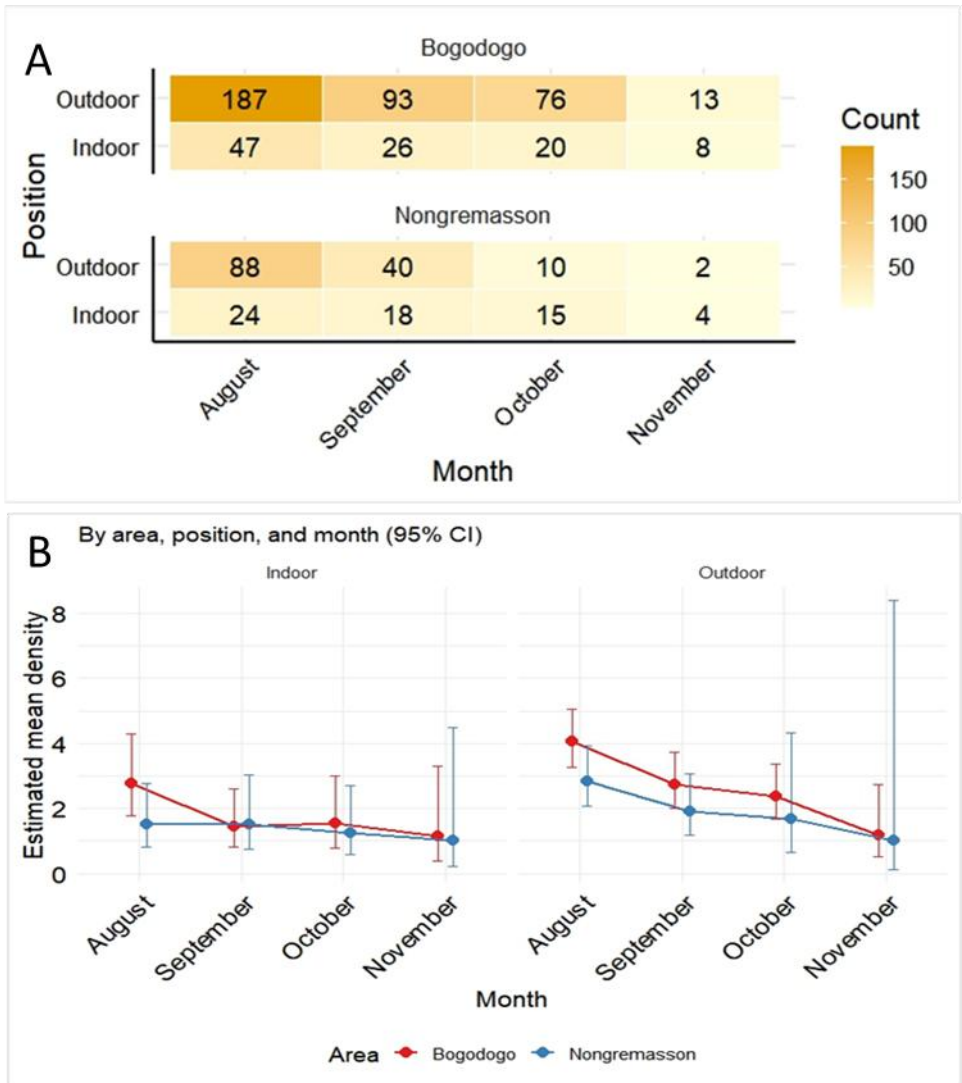


Figure 3: Monthly variation of number of *Aedes* mosquitoes, **A:** number heatmap of *Ae. aegypti* females; **B:** estimated marginal means of *Ae. aegypti* density by area and position

II.3. Distribution of *Ae. aegypti* females by physiological condition and capture position

The collection location of *Aedes aegypti* females varied according to physiological condition (Figure 4). Partially fed and unfed females were significantly more frequent outdoors, 71.4% and 74.9%, respectively. Fed females were slightly more collected outdoors (59%) but with no

statistical significance ($p = 0.174$), and gravid females showed no significant preference between indoor and outdoor resting locations.



Figure 4: Proportion of *Aedes aegypti* females according to physiological condition and collection location

II.4. Blood meal origin of *Aedes aegypti*

Out of a total of 58 mosquitoes analysed, 44 (75.9%) were successfully amplified by PCR for the detection of the blood-meal origin of humans, cows, dogs, and goats. Human blood meal represented 84.1% (37/44) of the collected mosquitoes tested. The total animal blood meal exclusively represented 11.36% (5/44) (Table II). A mixed human/dog blood meal represented 4.5% (2/44) of the blood meals. Among the animal blood meals, the dog was the most predominant with a percentage of 42.9% (3/7).

Table II: Blood meal origin of *Aedes aegypti*

Host	Number	Proportion (%)
Human	37	84,1
Dog	3	6,8
cattle	1	2,3
Goat	1	2,3
Human & Dog	2	4,5
Total	44	100,0

III. Discussion

This study aimed to characterise the abundance, resting preferences and blood meal of *Aedes aegypti* in Ouagadougou during the high dengue transmission period.

The indoor and outdoor collection of mosquitoes from households enabled us to characterise the resting behaviour of *Ae. aegypti*, the dengue vector in Ouagadougou. Understanding resting behaviour is of major public health importance, as it informs the selection of vector control strategy and guides decision on indoor/outdoor insecticide spraying.

Overall, we found that more mosquitoes were collected outdoors than indoors, suggesting a predominantly exophilic behaviour of *Ae. Aegypti* in Ouagadougou. Outdoor environmental conditions such as shade, vegetation and availability of oviposition sites, may be suitable for *Aedes* mosquito. Previous study in Ouagadougou support the high outdoor resting behaviour (8). Similar observation of trend to outdoor resting was reported in other Sub-Saharan Africa countries such Ethiopia (9) and Kenya (21). Contrary to this finding, *Ae aegypti* was found resting more indoor or equally both indoor and outdoor in Senegal (10). This variability of resting behaviour in *Ae. Aegypti* across Africa (7) suggests future investigation to better understand the environmental or genetic factors behind this resting behaviour plasticity.

We also investigated the trophic preference and reported high anthropophilic rate of 83.7% of *Ae. aegypti*. The anthropophilic rate has been demonstrated to be a crucial parameters for mosquitoes borne diseases transmission (11). Previous study reported high anthropophilic rate of *Ae. Aegypti* from Ouagadougou (>90%) (8). Similar finding were reported in other previous from sub-saharan African countries (22, 23). This high anthropophilic rate has an implication of diseases transmission as strong human blood preference suggest more human biting and more diseases spraying. The proportion of blood-fed mosquitoes in outdoor collection could also suggested that they feed and rest outdoor. This is particularly relevant while designing design vector control strategy as outdoor spraying of insecticide could reach these mosquito populations. However, understanding the host seeking behaviour could provide value additional information

The study was performed during the rainy season, which may represent a limitation in capturing temporal variability in mosquito density, resting behaviour and blood-feeding patterns throughout the season. In addition, the origin of blood meals for 12 samples could not be enough to be successfully determined by PCR requiring further investigation.

Conclusion

This study provided key evidence of outdoor resting behaviour and a high anthropophilic rate of *Ae. aegypti* in Ouagadougou, the capital city of the country, where most of the dengue transmission occurs. These resting and feeding behaviours have important implications for disease transmission and vector control. Strategy based solely on indoor insecticide spraying may have limited effectiveness. Integrated approaches that target both outdoor and indoor resting sites as well as animal hosts are therefore more likely to achieve a meaningful impact.

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Conflicts of Interest

The authors declare no conflicts of interest.

Authors contributions

HKT, SD, MWG: conception and design of study; **IT, SZ, IT, JCWWD:** data collection; **HKT, IT, SZ:** analysis and interpretation of data, **MWG, IS:** supervision and validation; **HKT, IT:** drafting the first draft of manuscript; **HKT, IT, SZ, MWG, SD and IS** revising it critically for important intellectual content, **All the authors:** final approval of the version to be submitted

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Ethical considerations

The study received approval from both the CNRFP institutional ethical committee and ethical committee for health research (*Comité d'éthique pour la Recherche en Santé, CERS*) of the Ministry of Health under deliberation number CERS deliberation no. 2020_07_122. Signed informed consent was obtained from household heads prior to mosquito's collection. The team worked with local guide to facilitate access to the population and get into their households.

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