Impact of Urbanization on Malaria Infection in Selected Urban Areas of Imo State, Nigeria

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Abstract

Malaria remains a major public health concern in Nigeria, with **urbanization** altering traditional transmission patterns. This study investigated the **impact of urbanization on malaria infection** in three urban centers of Imo State—Owerri, Orlu, and Okigwe. A **cross-sectional hospital-based survey** was conducted between April and July 2024, involving 600 participants (200 per zone). Venous blood samples were examined using **Rapid Diagnostic Tests (RDTs)** and **microscopy** to detect malaria parasites and estimate parasite densities. Structured questionnaires captured participants' demographic, socioeconomic, and migratory backgrounds. Results showed an overall prevalence of 34.5%, with Orlu recording the highest (38.0%) and Okigwe the lowest (30.0%). **Migrants** exhibited higher infection rates and parasite densities compared to non-migrants, particularly among females and low-income groups. Environmental conditions such as poor drainage, stagnant water, and overcrowded settlements further sustained transmission within urban neighborhoods. Statistical analysis revealed significant associations between malaria prevalence and migration status ($p < 0.05$), while age and sex showed no significant effect. The study underscores the role of population mobility and inadequate urban infrastructure in maintaining malaria transmission cycles. Effective control requires **integrated vector management**, improved diagnostic coverage, and **gender-sensitive interventions** within urban health frameworks. These findings provide valuable baseline data for targeted malaria control and urban health policy in Imo State and similar rapidly growing cities in sub-Saharan Africa.

Keywords: Urbanization, Malaria prevalence, Migration, Parasite density, Urban health

Introduction

With sub-Saharan Africa disproportionately impacted, malaria still presents a major public health problem throughout tropical and subtropical areas. Caused mostly by Plasmodium falciparum parasites, this mosquito-borne disease is transmitted through the bites of infected female Anopheles mosquitoes (World Health Organization [WHO], 2020). Malaria shows clinically with symptoms including fever, chills, and flu-like disease that might become major problems or death if not quickly treated. Nigeria carries a disproportionate load—about 27% of world malaria cases and 31% of—despite ongoing worldwide efforts in malaria prevention, diagnosis, and treatment. Death from malaria in 2022 (Severe Malaria Observatory, 2024). Children under five and expectant women are particularly vulnerable groups, which shows the complicated relationship between malaria and poor infrastructure, poverty, and limited access to medical treatment. Malaria was formerly seen as a rural illness, but increased urbanization all across Africa is swiftly altering its epidemiology. Unplanned urban sprawl and accelerated rural-to-urban migration have changed transmission patterns, which match predictions that almost 70% of Africa's population will be urbanized by 2050. (United Nations [UN], 2018). With towns such as those in Imo State seeing major population increase propelled by migration, infrastructure improvements, and population growth, Nigeria reflects this trend.

Although urbanization often increases access to healthcare, hygiene, and education, its overall effect on malaria transmission is complicated and context-dependent. Previous ideas held that better homes, fewer natural mosquito breeding locations, and more pollution repellents (Trape, Rogier, Hay, Smith, & Snow, 2005; Konate, 1987). Unintended, poorly controlled urban expansion, though, helps create environments appropriate for malaria transmission, according to recent research. Informal settlements provide rich breeding grounds for Anopheles mosquitoes (Doumbe-Belisse,

Estevez, &) with poor drainage, stagnant water in garbage and containers, and urban agriculture. Additionally exploiting co ntaminated water sources and the microclim ates generated, vector species including previously rural-adapted Anopheles arabiensis have progressively colonized urban ecosystems (Tchoumi, 2021). by urbanization (Jones, Craig, & Shutes, 2012). This has caused increased malaria transmission in Nigeria's peri-urban regions and metropolitan forests as we ll as throughout the Gulf of Guinea (Coluzzi, Sabatini, Petrarca, & Di Deco, 1979; Awolola, Oyewole, Obansa, & Abilio, 2002; Onyabe, Awolola, & Ferreira, 2001). Urbanization causes changes in land use, including deforestation, wetland drainage, and more construction, which affect vector ecology differently; some modifications lower breeding grounds whereas others, especially in uncontrolled U rban fringes improve vector productivity (Samson, Ekem, & Akinyemi, 2015; Bhattarai, Ali, & Koo, 2020). Rural immigrants often resid e in congested communities without enough public amenities and cleanliness, hence incre asing the risk of malaria transmission in quic kly developing cities of Imo State. Urbanization so has multiple effects: well-planned urban infrastructure can reduce malaria risk through better living conditions and health services, whereas unplanned urban sprawl may sustain or aggravate transmission (Agegnehu, Haile, & Kassahun, 2018; Utzinger et al., 2004). Human movement between rural and urban areas also helps parasite and vector distribution. with invasive urban-adapted vectors Anopheles stephensi exacerbating control difficulties (WHO, 2021).

Imo State is a prime illustration of these dynamics. Along infrastructural gaps, inadeq uate hygiene, and environmental degradation, urban center s like Owerri, Orlu, and Okigwe are seeing q uick population expansion. The coexistence of formal housing and informal settlements next to subpar drainage and wast e management systems produces ecological niches favoring malaria vectors and continued transmission. This emphasize s the need of a thorough evaluation of how malaria infection risk varies in these urban settings.

Methodology

Conducted in Imo State, Southeastern Nigeria, Owerri, Orlu, and Okigwe comprised three geopolitical zones spanning around 5,100 km². One local Chosen intentionally, Government Area (LGA) from each zone—Owerri Municipal, Orlu LGA, and Okigwe LGA— represented the major urban areas of the state. Temperatures in the area range from 2 2°C to 30°C and average annual rainfall is about 2,000 mm, hence it has a tropical climate. Mostly t ropical rainforest vegetation defines a terrain that ranges from low plains to undulating hills. Along infrastructural and environmental obstacles appropriate for mal aria transmission, these metropolitan areas a re experiencing fast population increase. The Institutional Ethics Committee of Imo State University granted ethical authorization. Permission was also secured f rom the State Ministry of Health, local health agencies, and appropriate hospital managements. Parti cipation was voluntary with knowledgeable permission, and participant data confidentiality was meticulously preser ved.

Between April and July, a cross-sectional hospital-based methodology was used. Patients from Okigwe General Hospital, Ivory Clinic Okigwe, Orlu Teaching Hospital, and Owerri Specialist Hospital, Umuguma, were included in the study. Stratified random sampling was used to draw six hundred volunteers (200 per zone). Using Lemeshow et al.'s formula with $\alpha = 0.05$ and estimated malaria prevalence $p = 0.187$, sample size was computed to produce a minimum size of 200 per location. Venous blood draws and interviewer-administered organized questionnaires gathe ring demographic, socioeconomic, and behavioral malaria risk markers defined data collection. Trained laboratory personnel gathered 5 ml blood samples into EDTA vials and processed them within 72 hours. Malarial diagnosis included Rapid Diagnostic Tests (CareStart™ Malaria Pf HRP2 Ag RDT) as instructed by manufacturers and microscopic analysis of Giemsa-stained thick and thin blood smears for species identification and parasite density measurement. At 100X oil immersio n, thick smears were inspected; parasite density was estimated based on 8,000 leukocytes/µl. Reexamination of all

positive smears and 10% of them served for quality control. negative slides from an independent microscopist who has been blinded. Trained assistants distributed questionnaires in English and, where appropriate, translated them into regional languages. To assess links between urbanization factors an d results of malaria infection, STATA softw are was used for data analysis.

Results

Table 1

Studies reveal that malaria infection frequency varied between migrants and non-migrants across all zones. In Orlu and Okigwe, migrants showed greater infection r ates—particularly among women; male non-migrants displayed a higher infection rate in Owerri. Female migrants consistently documented the highest prevalence in most areas, therefore highlighting a strong g endered sensitivity among immigrant groups .

Distribution of Malaria Infection Among Migrants and Non-Migrants by Sex and Zone in Imo State

Zone	**Group**	**Male Examined**	**Male Infected (%)**	**Female Examined**	**Female Infected (%)**	**Total Examined**	**Total Infected (%)**
Orlu	Migrants	40	50.0 (20/40)	45	35.6 (16/45)	85	42.4 (36/85)
	Non-Migrants	55	18.2 (10/55)	60	50.0 (30/60)	115	34.8 (40/115)
	Total	95	31.6	105	43.8	200	38.0

Zone	Group	Male Examined	Male Infected (%)	Female Examined	Female Infected (%)	Total Examined	Total Infected (%)
			(30/95)		(46/105)		(76/200)
Okigwe	Migrants	44	22.7 (10/44)	18	44.4 (8/18)	62	32.3 (20/62)
	Non-Migrants	35	28.6 (10/35)	103	31.1 (32/103)	138	29.0 (40/138)
	Total	79	25.3 (20/79)	121	33.1 (40/121)	200	30.0 (60/200)
Owerri	Migrants	50	30.0 (15/50)	50	50.0 (25/50)	100	40.0 (40/100)
	Non-Migrants	30	50.0 (15/30)	70	22.9 (16/70)	100	31.0 (31/100)
	Total	80	37.5 (30/80)	120	34.2 (41/120)	200	35.5 (71/200)

Note. Percentages represent number infected per number examined (in parentheses).

Table 2

This shows that among migrants, most especially in Okigwe, parasite densities were usually higher than those of non-migrants— 6,000 parasites per μL. Migrants showed significantly higher average parasite loads, indicative of greater exposure or impaired immunity, even if ranges overlapped in Orlu and Owerri.

Malaria Parasite Density Comparison Between Malaria-Positive Migrants and Non-Migrants Across Zones (parasites/μL)

Zone	Migrants Parasite Density Range	Non-Migrants Parasite Density Range
Orlu	1,568 – 6,416; several >4,000	1,568 – 5,136; moderate-high values
Okigwe	1,680 – 6,560; many >4,000	1,600 – 4,960; mostly moderate
Owerri	1,600 – 5,024; consistently high	1,424 – 4,800; wide range

Note. Higher parasite density indicates greater malaria infection intensity.

Table 3

This table documents substantial variability in parasite densities among migrants by their areas of origin and residence, with densities ranging from approximately 1,700 to over 6,500 parasites/μL. Migrants from high transmission areas such as Ehime Mbano, Isiala Mbano, and neighboring states frequently carried higher parasite burdens, suggesting they contribute to maintaining active transmission cycles within urban environments.

Malaria Parasite Densities Among Migrants by Origin and Place of Residence

Origin	Place of Residence	Parasite Density (parasites/µL)
Ehime Mbano	Eziachi Orlu	2,112 – 6,416
Ihube	Ezinachi Okigwe	4,304 – 5,600
Aboh Mbaise	Okigwe	6,560
Orlu (Umuna)	Owerri	1,728 – 4,800
Abia State	Owerri	2,512

Note. Parasite densities vary by migrant origin and residence, indicating differing infection severities.

Discussion

Stratified by their country of origin and residence, malaria parasite density among migrants in Imo State analysis shows major heterogeneity in infection intensity. Emphasizing the varying intensity of infections associated to migratory patterns and originating regions, parasite densities ranged from fairly low (around 1,728 parasites/µL) to urgently high burdens above 6,560 parasites/µL. Migrants from regions with high malaria transmission, including Ehime Mbano (Eziachi Orlu) and Aboh Mbaise (Okigwe), showed some of the greatest observed parasite loads, usually exceeding 4,000 parasites per µL, migrants from Aboh Mbaise's peak density was 6,560

parasites per μL. These high parasitemia levels probably result from strong exposure in their birth regions combined with restricted access to quick and successful antimalarial treatment and just partial Development of immunity via recurrent infections (Ebeh-Njoku et al., 2025). This result fits well with earlier resea rch in Imo State, where widespread infrastructural shortcomin gs, inadequate hygiene, and limited healthca re access exacerbate local malaria transmission (Ebeh-Njoku et al., 2025). Migrants from peri-urban or rural Imo areas (such as Orlu Umuna) and nearby Abia State moving into cities like Owerri likewise displayed great parasitemia ranging from 1,728 to 4,800 parasites/μL. This active carriage of parasites into urban environments matches epidemiological patterns increasingly documented across Nigeria (Nwaka, 2018). and Sub-Saharan Africa (Bhattarai, Ali, & Koo, 2020). Human population movements from endemic rural to urban areas help to introduce and sustain malaria transmission in Cities that had previously been regarded to be lower-risk because of superior infrastructure and housing (Makinde, Odeyemi, & Oladele, 2020; Onyiah, Chukwuocha, & Eze, 2021). The migration-driven beginning Urban centers' parasitologi cal presence supports transmission cycles and impedes elimination attempts.

Observations by Ujuju, Ongom, and Asibor (2020), which highlight the variance in immunity level, fit the wide spectrum of parasite densities seen among migrants. and treatment-seeking activities among migrant population s. High-transmission sources often lack the strong acquired immunity of long-time metropolitan inhabitants, therefore mak ing them more vulnerable to serious malaria and greater parasite loads (Ihenetu, 2016). Migrants with mild parasitemia, on the other hand, can be in early phases of treatment or could have partially developed immunity following exposure reduction after migration. These results have major ramifications for in itiatives aimed at eradic malaria in Nigeria's fast growing urbanized areas. Continual influx of migrants from high-transmission hinterlands causes urban centers like Owerri and Okigwe to have ongoing difficulty breaking transmission

cycles, particularly in environments wracked by environmental elements including infor mal settlements, inadequate drainage, and inadequate housing that promote vector reproduction (Akinwale, Odewale, & Ajayi, 2019). Migrants carrying high-density parasitemia increase local transmission hazards, therefore highlighting the need for creative solutions including targeted screening and treatment of mobile populations. together with tactical environm ental management to lower vector breeding habitats (Mberu, Haregu, Kyobutungi, & Ezeh, 2016; Tapera, Mufuka, & Chimedza, 2017). Furthermore, the results highlight the value of including spati al and mobility data into malaria surveillance systems to detect hotspots accurately and inform targ eted treatments (Onyibe, Awolola, & Ferreira, 2019). Given the sharp social and gender inequities seen—especially the greater vulnerability of female migrants—malaria control plans must use gender-sensitive methods that acknowledge and sol ve women's vulnerability. specific exposure risks and access obstacles to healthcare in Nigerian cities (Ejezie, Mbah, & Eze, 2022).

In synthesis, the data clearly show that internal migration has a major effect on malaria parasite density profiles and transmission dynamics in the urban areas of Imo State. Effective malaria control initiatives must thus include migratio n-aware approaches that improve diagnosis, th erapy, vector management, and community education in source as well as destination areas in order to continuously interrupt transmission cycles.

The results of this study are supported by rising literature on urban malaria in Nigeria and sub-Saharan Africa. Higher malaria prevalence and parasite densities among migrants than among established urban inhabitants have been consistently shown; this is mostly ascribed to weaker immunity and restricted healthcare. Access following relocation (Ebeh-Njoku et al., 2025; Mohammed & Oda, 2024). The seen gender-driven differences in which female immigra nts experience disproportionate infection hazards further validate social Imp ortant modulators of malaria vulnerability are determinants (Ujuju,

Ongom, & Asibor, 2020; Ejezie et al., 2022). The high parasite densities among immigrants in Okigwe Owerri indicates that, in line with c omparable urban African settings (Ihenetu, 2016; Onyibe et al., 2019), they may act as reservoirs assisting continuous transmission. Considered together, these results support context-specific integrated treatments directed at mi grant groups, better urban infrastructure, healthcare access, and vector control. Such methods fit with more general African malaria control objectives stressing equality and adaptability to fast changes in environment and population that define urba nizing settings (Akinwale et Mberu et al., 2016; al., 2019)

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