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Prevalence of Typhoid Fever and malaria co-infection among patients visiting selected hospitals in Aba, Abia State, Nigeria

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Abstract
The co-infection of malaria and typhoid fever significantly impacts human health, particularly in Sub-Saharan Africa (SSA). Inhabitants of these regions are always at risk of contracting both infections simultaneously due to environmental and socio-economic factors that favor their transmission. A study of co-infection of typhoid and malaria fevers was carried out on 120 patients attending both inpatient and outpatient clinics of various hospitals in Aba, Abia State. Blood specimens were collected from patients, and the blood was used to test for malaria parasites and *Salmonella typhi*. Thick and thin blood films stained in the field were used to detect malaria parasites in samples. Typhoid fever was diagnosed from each blood sample using a Widal test kit. Of the 120 patients sampled, 83 (69.17%) tested positive for malaria, 59 (49.17%) for typhoid fever, and 44 (36.7%) were infected with both. More females (37.1%) than males (36.2%) were afflicted with malaria and typhoid fever. Malaria and typhoid fever co-infection was highest in the 20-29 age group (44.4%), while the 0-9 age group had the lowest prevalence of 25%, followed by the 60+ age group (27.3%). Enhancement of sanitary conditions, personal hygiene, and the reduction of malaria vectors and housefly breeding areas are recommended to decrease illness transmission.

Keywords: Malaria, Typhoid, Fever, co-infection, blood

Introduction

Malaria is a febrile illness and the world's most prevalent deadly disease caused by one or more plasmodium species (World Health Organisation, 2018). These include *Plasmodium falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi*. However, *P. falciparum* is responsible for most deaths because other malaria parasites induce a milder form. The disease is transmitted through the bite of female anopheles' mosquitos, and symptoms usually appear ten to fifteen days following the bite. Malaria symptoms can include fever, fatigue, vomiting, and headaches. In severe cases, it can cause yellow skin, seizures, coma, or death (Mohammed *et al*., 2020) [4].

Globally, an estimated half of the world's population (3.4 billion people) lives in areas at risk of malaria infections, with the Sub-Saharan region, particularly Nigeria, having the highest burden (World Health Organization, 2018). More than half of Nigeria's population is estimated to experience at least one episode of malaria each year, contributing to approximately 30%of outpatient visits, 20%of all hospital admissions, and 10%of hospital deaths (Akinola, 2024) [1].

Conversely, typhoid fever, commonly referred to as "typhoid", is a bacterial infection caused by *Salmonella typhi*, also known as *Salmonella enterica* serotype Typhi (Modebe *et al*., 2014; Wain *et al*., 2015) [3, 15]. It remains an important worldwide cause of morbidity and mortality and continues to be a public health problem in developing countries where there is poor sanitation, poor standard of personal hygiene and unsafe food and water supply. One of the risk factors is poverty brought on by inadequate hygiene and sanitation (Wain *et al*., 2015) [15]. Mohammad *et al*. (2020) state that there are approximately 33 million cases of typhoid fever globally, with endemic areas accounting for 216,000 fatalities (Sohanang Nodem *et al*., 2023) [13]. Its prevalence spans vast stretches of Asia, Africa, and Latin America (Olowolafe *et al*., 2024) [9].

Coinfection of malaria and typhoid fever is of great concern in Nigeria because of the geographic overlap of both infections. However, the precise incidence of the concurrent malaria and typhoid fever in most geographical areas is largely uncertain, as both share social circumstances which are imperative to their transmission; people who live in areas where both diseases are endemic are at substantial risk of contracting both these diseases, either simultaneously or an acute infection secondary to on a chronic one.

The condition often presents a diagnostic challenge and, in some situations, may lead to diagnostic confusion. Patients falsely diagnosed with typhoid alongside malaria in Nigeria are typically initiated on broad-spectrum antibiotics in addition to anti-malarial medications without undergoing confirmatory tests. This widespread administration of broad-spectrum antibiotics has contributed to the rising incidence of antimicrobial resistance, consequently amplifying mortality rates. Hence, this study was carried out to determine the prevalence of malaria, typhoid, and their confection in patients attending selected hospitals in Aba, Abia State, Nigeria.

Materials and Methods

Study Area

This study was conducted in Aba, Southeast Nigeria. Aba (5°07'23"N, 7°22'108"E) is a commercial hub of Abia state.

It is a cosmopolitan town located 64 km from the state capital. Predominant occupation is trading and other commercial activities. The city is topographically with sloppy sites. The flatness, in addition to a poor drainage system, makes Aba prone to flooding during the rainy season, resulting in the formation of temporary water bodies, which are numerous during rainy seasons, the presence of which makes Aba a veritable breeding ground for mosquito vectors of malaria parasites. The area is characterized by a long dry season (November, December, January-March) and a longer rainy season (April-October). The mean annual rainfall is between 2,500 and 3,000 mm. Monthly mean temperature ranges from 25-32°C, while mean relative humidity ranges from 60-90%. The highest and lowest monthly mean relative humidity is observed during the rainy and dry seasons.

Ethical Considerations

Permission was obtained from the management of three private hospitals used for the study, and from the head of the laboratory/technical staff section of various hospitals before the commencement of the study on the agreement that patient anonymity must be maintained and that every finding would be treated with utmost confidentiality for this research only. Consent of the patients was also sought and received before being included in the study. For the children, consent was received from their parents before they were included in the study.

Study Population/Sample Collection

Blood samples were obtained from 120 patients attending three private hospitals in Aba, Abia State, between August and September 2024. Sample questionnaires were administered to obtain information on the socio-demographic profile of the respondents. The protocol of the study was properly explained to each of the subjects before blood collection by the health practitioner. Five milliliters (5 mL) of venous blood were collected aseptically from each respondent using a sterile syringe by the health practitioner in the hospital and dispensed into an Ethylene diamine tetra-acetic acid (EDTA) bottle and gently mixed. The samples were taken immediately to the Department of Biology/ Microbiology Laboratory of Ogbonnaya Onu Polytechnic, Aba, for processing.

Detection of malarial parasites

Thick films were prepared by placing a drop of blood at the centre of grease-free glass slides and spreading (circular movement) using a spreader to make a smear of about 12 mm. The blood films were allowed to air-dry and then stained with 10% Giemsa stain for 10 minutes to detect *Plasmodium* parasites. The slides were examined microscopically under 100x (oil immersion) objective, according to Iwuafor (2016).

Typhoid Fever Detection

Widal slide testing was performed as a rapid slide test. This diagnostic reagent kit was used to identify antibodies generated in response to Salmonella-specific antigens.

The dead bacterial suspension included Salmonella-specific "O" and "H" antigens. This will react with immunospecific antibodies in the patient's serum and bind to the antigen, resulting in agglutination or clumping on the slide. Procedures were carried out following the manufacturer's instructions for the test kit. On the slide test, one drop of the patient's serum on each circle was added, one drop of antigens "O", "H", "AH", and "BH." It was then mixed well and agglutinated to be observed after 1 minute. The agglutination was visible within 1 minute, and then it was proceeded for quantitative estimation. As positive values ≥1:80, antibody titers for "O", "H", "AH", and "BH" antigens were considered.

Results and Discussion

Prevalence of malaria and typhoid

This study diagnosed 83(69.17%) malaria patients and 59(49.17%) typhoid patients.

Gender-wise Prevalence in Percentages

The influence of gender on the prevalence of malaria in selected hospitals showed that out of 120 sampled patients, 67.24% of male patients were malaria positive, whereas 70.97% of female patients were malaria positive. Among the typhoid patients, males had a higher prevalence, 33(56.9%), than females, 26(41.9%).

Age-wise Prevalence in Percentages

This study diagnosed 83(69.17%) malaria patients; 20–29 years had the highest prevalence of 94.44% while 0- 9 years (40%) had the least prevalence. Among the 59(49.17%) typhoid patients, 16–19 years had the highest prevalence, 16(76.2%), while 0- 9 years 2(10%) had the least prevalence.

Coinfection prevalence

44(36.7%) patients were coinfected with malaria and typhoid. In patients with coinfections of typhoid and malaria, 44.4% of the patients were found in the age group of 20–29 years, 27.3% found in both age groups above 60 years, and 25% of the patients were found in the 0–9 year's age group. Females had a higher prevalence of 37.1% than males, 36.2%.

Table 1: Prevalence of malaria parasite in relation to age/sex among patients in Aba.

Age (years)	Total No. Examined	Male		Female		Total Prevalence (%)
		No. Examined	No. Infected (%)	No. Examined	No. Infected (%)	
0 - 9	20	12	5(41.67)	8	3(37.5)	8(40)
11-19	21	10	9(90)	11	10(90.91)	19(90.48)
20-29	18	09	8(88.89)	09	9(100)	17(94.44)
30-39	19	10	8(80)	09	7(77.78)	15(78.95)
40-49	16	6	4(66.67)	10	7(70.0)	11(68.75)
50-59	15	7	4(57.14)	08	4(50)	8(53.33)
≥60	11	4	1(25)	07	4(57.14)	5(45.45)
Total	120	58	39(67.24)	62	44(70.97)	83(69.17)

Table 2: Prevalence of Typhoid infection in relation to age/sex among patients attending various hospitals in Aba, Abia State.

Age (years)	Total No. Examined	Male		Female		Total Prevalence (%)
		No. Examined	No. Infected (%)	No. Examined	No. Infected (%)	
0-9	20	12	2(16.7)	08	0(0)	2(10)
10-19	21	10	7(70)	11	9(81.8)	16(76.2)
20-29	18	09	5(55.6)	09	2(22.2)	7(38.9)
30-39	19	10	7(70)	09	2(22.2)	9(47.4)
40-49	16	06	4(66.7)	10	6(60)	11(62.5)
50-59	15	07	5(71.4)	08	4(50)	9(60)
≥60	11	04	3(75)	07	3(42.9)	6(54.5)
Total	120	58	33(56.9)	62	26(41.9)	59(49.17)

Table 3: Prevalence of Malaria parasite and Typhoid co-infection in relation to age/sex among patients attending various hospitals in Aba.

Age (years)	Total No. Examined	Male		Female		Total Prevalence (%)
		No. Examined	No. Infected (%)	No. Examined	No. Infected (%)	
0-9	20	12	3(25)	08	2(25)	5(25)
10-19	21	10	4(40)	11	5(45.5)	9(42.9)
20-29	18	09	3(33.3)	09	5(55.6)	8(44.4)
30-39	19	10	5(50)	09	3(33.3)	8(42.1)
40-49	16	06	2(33.3)	10	4(40)	6(37.5)
50-59	15	07	3(42.9)	08	2(25)	5(33.3)
≥60	11	04	1(25)	07	2(28.6)	3(27.3)
Total	120	58	21(36.2)	62	23(37.1)	44(36.7)

Discussion

Malaria and typhoid fever are serious public health concerns in Sub-Saharan Africa, especially in Nigeria. Malaria is a parasitic disease, while typhoid is a bacterial infection. The two coexist, particularly when living conditions are extremely poor. The findings show that the malaria parasite had a total percentage prevalence of 69.17% among patients visiting various hospitals in Aba. This is quite high. It shows that mosquitoes' breeding, inoculation, and transmission rate are very high, hence the study area is endemic for malaria. The high prevalence of malaria parasitaemia in Aba can be attributed to environmental conditions, including altitude, rainfall, and dense vegetation, all of which favor mosquito reproduction and transmission.

This prevalence is higher than that reported in a clinic-based study from Kogi State, which focused on pregnant women attending antenatal clinics (Okolo *et al*., 2023) [7], but lower than the 60.5% recorded among university students in Akure (Simon-Oke & Akinbote, 2020) [12] and 78.90% among patients attending FMC, Umuahia (Dike-Ndudim *et al*., 2022) [2]. The differences in prevalence rates may be influenced by the varying study populations: this study's hospital-based records likely reflect higher prevalence due to individuals seeking medical care, whereas community-based studies may include asymptomatic or mildly symptomatic individuals, potentially resulting in different prevalence rates.

This study found that females had a higher malaria prevalence, consistent with findings of Okore *et al*. (2015) [8] and Odoemene *et al*. (2022) [5], where females also showed a higher prevalence. This could be due to hormonal differences or pregnancy. However, this contrasts with a study from Calabar, which reported a higher prevalence in males Orok *et al.* (2016) [11] and Ukpai & Ubiaru, (2016) [14]. It could also be attributed to this work being a clinical study because most males delayed more than women before going to hospital. The risks of transmission of malaria cut across all age groups, which have little to no immunity against *Plasmodium* spp. infections (Wanjala *et al*., 2011) [16].

The overall prevalence of typhoid was 49.17%. This is comparable to an overall prevalence rate of 45.8 % typhoid infection in two referral hospitals in Abia State reported by Onwuchekwa *et al*. (2019) [10]; however, in variance with a study by Ogwuebu *et al*. (2016), who reported the prevalence rate of typhoid infection in Imo State was 19.6%. The variations observed in this study and others could be attributed to differences in Widal test kit readings, variations in the seasons during which the research was conducted, cultural behaviors in different study areas, inadequate bathroom facilities, a lack of access to drinking water, and poor personal hygiene. The males had the highest prevalence (56.9%). Males may have a higher prevalence because they frequently visit roadside restaurants with inadequate hygiene standards.

44 (36.7%) patients were afflicted with both malaria and typhoid. Females showed a greater frequency of 37.1% than males (36.2%). This high prevalence in females could be attributed to the fact that females are more involved in activities such as farming, which exposes them to mosquito bites, and domestic chores, in which they come into constant contact with water from poorly managed springs or streams that may be contaminated with *Salmonella* spp. The age group 20-29 years had the highest prevalence of coinfection, whereas 0-9 years, followed by the age group > 60 years, had the lowest frequency. The reason could be the former age groups are very active age groups that engage in a lot of activities like farming, artisans, keeping late night, eating at events, eating at the road site and many more, all these predisposes them to malaria and typhoid risk factors compared to the age group 0-9 years and age group ≥ 60 years which are more of the infants and elderly and have very reduced activities. Among those being managed for typhoid fever and malaria concurrently, only 36.7% had coinfection. This implies that other pathogens may be responsible for the febrile illness seen in these patients. The

findings indicate that there is a need for improved detection of the cause of febrile illness in our communities to ensure successful treatment and prevent pathogen resistance to existing medications.

Conclusion

The present study revealed that both malaria and typhoid fever remain diseases of public health concern in the study area. Notably though there as a 36.7% co - infection rate, the prevalence of malaria was higher than typhoid fever. This information is important for public health planning as it brings to light the high burden of malaria in our locality. Most times patients are being treated concurrently for malaria and typhoid because appropriate diagnostic tests are not always available. This is a cause for concern as it implies that several people are given antibiotics or antimalarial medication that they don't need, basically because of reliance on symptomatology as the mainstay for diagnosis. The consequence of this misdiagnosis and hence mistreatment is economic burden and drug resistance as a result of drug abuse or misuse. Therefore, to reduce the burden of malaria and/ or typhoid fever in the area, strategies for the prevention and control of malaria and typhoid fever should be fully employed. In addition, there is the need for government to step up policies aimed at improving sanitation, providing social amenities such as safe water supplies, and mass literacy campaigns to increase people's awareness of the available preventive measures.

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