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Assessment of Malaria Parasite Intensity in Mono-Infected and Typhoid Co-Infected Patients Attending Selected Health Facilities in Wukari, Taraba State

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Abstract

This study compared malaria parasite intensity in mono-infection and in co-infection with typhoid among febrile patients attending selected health facilities in Wukari. A total of 418 patients were enrolled based on clinical diagnosis of febrile illness, and from each patient blood and stool samples were collected for blood film examination and stool culture, respectively. Overall, 75.3% of malaria-positive cases had low parasite intensity, whereas 24.7% had higher parasite density, with a statistically significant difference ($p < 0.001$). Among the 83 patients with malaria mono-infection, low-intensity (+) parasitemia was more frequent than high-intensity parasitemia. By contrast, in malaria–typhoid co-infection, 68.9% of patients with *Salmonella* co-infection had high malaria parasite intensity and 31.1% had low intensity, with an overall p value < 0.011. The odds ratio of 6.766 indicates that individuals with high malaria intensity have approximately sevenfold higher odds of developing typhoid fever

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compared with those with low malaria intensity. These results suggest that elevated malaria parasite density in co-infected patients is associated with a greater risk of typhoid and indicate that healthcare providers should maintain heightened vigilance for severe malaria presentations in patients with concurrent typhoid infection. The findings further underscore the need for comprehensive control programs targeting mosquito breeding sites and public education on improved sanitation to reduce the burden of malaria and typhoid co-infection.

Keywords: Malaria Parasite Intensity; Malaria–Typhoid Co-Infection; *Salmonella*; Odds Ratio; Vector Control.

INTRODUCTION

Malaria is a life threatening serious parasitic disease resulting from infection with *Plasmodium specie* transmitted by the bite of female anopheles mosquitoes (Dike-Ndudim, J.N. 2022). Malaria is a leading cause of illness and death in the developing world and a significant drag on economic development. The parasite was visualized in red blood cells by Lavern in 1880. Sir Ronald Ross subsequently proved that the infection was transmissible by mosquitoes to humans in 1879. (Dike-Ndudim, J.N. 2022).

Malaria and typhoid remain the major cause of morbidity and mortality in tropical and subtropical countries. It is common today to see patients being concurrently infected or treated for the two diseases. Malaria causes widespread deaths to children and economic hardships on poor households. (W.H.O; 2014, 2016, Vatang, 2018).It causes symptoms that typically include fever, fatigue, vomiting, and headaches. In severe cases, it can cause yellow skin, seizures, coma or death. (Mohammed *et al,* 2020). In the year 2018, WHO estimates that there were about 228 million cases of malaria and 405,000 malaria related deaths with 93.8% of deaths occurring in sub-Saharan Africa. (Sale *et al.,* 2020; Chipoya *et al.,* 2020).The majority of infections are caused by *Plasmodium falciparum* species, the most dangerous of the four human malaria parasites. (Chipoya *et al.,* 2020; Simon-Oke and Akinbole 2020).

Typhoid fever is an accurate systemic infection caused by *Salmonella typhi*, a gram and oxidase negative bacterium. It is mainly transmitted faeco-orally through contaminated food and water. There are about 33 million cases of typhoid annually in the world resulting in 216,000 deaths in endemic areas. (Mohammed *et al,* 2020). Outbreaks of typhoid fever

are frequently reported from sub-saharan Africa and countries in South East Asia. WHO identifies typhoid as a serious public health problem with high incidence on children, young adults and pregnant women (Mohammed *et al.,* 2020; WHO, 2016).

The most prominent feature of infection is fever which gradually rises to a high value. High fever, lethargy, skin rash, loss of appetite, constipation more than often, abdominal pain, diarrhea, hepatospleenomegaly, bradycardia and headaches are the commonest symptoms and without treatment, symptoms may last for weeks or months. (Simon-Oke *et al.,* 2020;Ubengama *et al.,* 2019). Both diseases mainly associated with poverty and under development with significant morbidity and mortality are common in many countries where the prevailing environmental conditions of warm humid climate, poor sanitary habits, poverty and ignorance exists for example Nigeria. (Sale *et al.,* 2020).

The high prevalence of typhoid fever could be attributed to the source of drinking water (such as water from uncovered well, contaminated satchet water and indiscriminate defaecation in bushes around water sources which is a common practice among students which could have contributed to the high burden of typhoid fever. (Bain, R and Wright, J.A; 2014). Sociodemographic parameter affecting the prevalence rate of typhoid fever is the level of education which is still low and prevalence was highest in primary educational level than any other levels. In addition, lower occurrence was recorded among patients who attended secondary and higher education, civil servants and merchants. This could be due to the fact that these groups have sufficient money and knowledge about typhoid fever and have visited ante natal clinics more than people with little or no education. (Onyido *et al.,* 2014).

In contrast, people with low level of education among illiterate and primary and secondary education groups particularly in rural areas are still low since most of them still believe that Africans are resistant to infectious diseases and therefore consume food and water available to them irrespective of hygienic standards. Malaria and Typhoid fever are two leading infections of poverty with serious health and socio-economic impact due to their geographical overlap, co-infections are very common (Onyido *et al* 2014). Since both have similar symptoms, treatment is based on adequate lab diagnosis.

Clinical evidence of pulmonary involvement in typhoid and paratyphoid fever is well recognized and common. Sepsis is common. These pathogenic disorders do not require vector as a medium in the process of transmission. The bacteria *Salmonella* can

spread from digestive tract to the blood stream (causing bacteremia) and may affect other organs such as lungs causing pneumonia, heart valves involvement causes endocarditis, joint involvement results in arthritis when not treated or delayed. Typoid fever starts with flu-like illness about 8 to 14 days after which fever, headache, sorethroat, muscle and joint pains, abdominal pains and dry cough, slow heart beat and the individual feels exhausted. Samples of blood, sputum and stool are used for diagnosis and culture is done. (Larry, 2024).

Malaria and typhoid fever are two febrile illnesses that cause varying degrees of illness and death in the tropics and subtropics, where malaria and typhoid fever are co-endemic. According to WHO global data on Malaria produced in 2021, about 241 million cases of malaria were diagnosed with 627,000 attributable deaths. (WHO, 2020). Two third of those deaths occurred in children under 5 mostly from Africa. (Mbacham *et al*, 2019).

At the same time, typhoid and paratyphoid fever, a systemic protracted febrile illness commonly caused by *S. typhi* and common in malaria-endemic settings resulted in 11 to 20 million cases and 20,000 deaths (Bonville, 2021)

Due to the lack of rapid, sensitive and reliable differential diagnosis for *Salmonella* in these settings with the mostly weak peripheral systems and resource constraints, cases of acute febrile illnesses are usually treated presumptively as malaria by clinicians (Stoler *et al.,* 2016).

However, differential diagnosis is problematic as most malaria-endemic areas are also co-endemic for other infectious diseases that cause fever such as typhoid fever, urinary tract infections and pneumonia (Stoler *et al.,* 2016).

MATERIALS AND METHODS

Study Area

Wukari Local Government Area is located on longitudes 7° 52N and Latitudes 9° 46E and having an area of 4,308 km^2 with a population of 241,546 based on the census conducted in 2006. It shares boundaries with Plateau state, Ibi LGA and Gassol LGA to the north as well as Nasarawa state and Donga LGA to the south. Agricultural products like yams and fishes can be found in these areas since the people are predominantly farmers (Ishaku *et al*., 2009).

Setting

The participants for this study were recruited from three health facilities in Wukari metropolis namely: Federal University Teaching Hospital Wukari, Christian Reformed Church of Nigeria (CRCN) Hospital Mission Wukari and Primary Health Center all in Wukari Taraba State Nigeria.

Sample Size and Sampling Technique

418 patients participated in the research.

Sampling Technique

The sampling method was random sampling and involved selection of patients as they came to the clinic. The patients who present with malaria and typhoid symptoms were enrolled in the study.

Exclusion criteria were patients who were unable to provide the required samples which were blood and stool.

Assessment of Safety

The blood sample was collected by qualified laboratory personnel to ensure safety.

Ethical Clearance

Ethical clearance was obtained after approval by the ethical committee of Federal University Teaching Hospital Wukari and Head of Primary Health Care Wukari Local Government.

Laboratory Methods

Stool culture

Procedure

i. Stool samples were inoculated using the aid of a sterile wire loop on *Salmonella-Shigella* agar for 24hrs at temperature of 35 to 37 degree *celsius*.
ii. After 24 hours of inoculation, the plates were read to identify the growth of the bacteria *Salmonella* which produces hydrogen sulphide resulting in blackening of colonies.

Blood film

Principle

Thick smears consist of a thick layer of dehemoglobinized (lysed) red blood cells. Thick smears allow a more efficient detection of parasites. It has increased sensitivity of 10 to 20 times more than thin film.

Procedure

1. 2-3 small drops of blood was spread into a circle of 1cm diameter on a clean slide.
2. Allowed to air dry
3. The giemsa stain was spread over the area of smear and allowed to stain for 10 minutes after which it was be washed.
4. The stained slide was be allowed to air dry and viewed at x100 oil immersion to identify the presence of malaria parasite (Norgan *et al.,* 2013)

Statistical Analysis

Data analysis was carried out through the aid of the statistical package for Social Sciences (SPSS) version 23. The results are presented in form of tables. Odds ratio and p-values were expressed to test for level of significance.

Data Handling and Record Keeping

Data collected and results were analysed and the information of the participants such as names were kept confidential and not reflected in any way in the research work.

Result Dissemination

The raw data collected was strictly for research purpose and the names are not reflected but kept confidential but the result after analysis could be published for academic research and for public awareness.

RESULTS

Table 1. Malaria Intensity in Cases of Mono-infection by Age and Sex

		Malaria Intensity		Chi square	P – value
		Low (%)	**High** (%)		
Sex	Male	21 (28.8)	10 (13.7)	1.675	0.196
	Female	34 (46.6)	8 (11.0)		
Age	0-2 Years	10 (13.7)	2 (2.7)	4.721	0.314
	3-12 Years	16 (21.9)	8 (11.0)		
	13-39 Years	22 (30.1)	4 (5.5)		
	40-49 Years	3 (4.1)	3 (4.1)		
	50-60 Years	4 (5.5)	1 (1.4)		
	Overall	55 (75.3)	18 (24.7)	18.753	< 0.001*

Table 1 shows the Malaria Intensity in cases of mono infection by age and sex.

The overall cases showed a significant p value <0.001.There is variation between the high intensity malaria cases from the low intensity cases when compared to the overall malaria cases which was a total number of 83 patients suffering only malaria without typhoid. In mono infection, malaria positives were more on the low intensity (+) when compared to the number of patients with higher intensity.

Table 2: Malaria Intensity in Cases of Co-infection by Age and Sex

		Malaria Intensity		Chi square	P- value
		Low (%)	**High** (%)		
Sex	Male	7 (15.6)	17 (37.8)	1.675	0.196
	Female	7 (15.6)	14 (31.1)		
Age	0-2 Years	1 (2.2)	2 (4.4)	9.822	0.039*
	3-12 Years	6 (13.3)	4 (8.9)		
	13-39 Years	4 (8.9)	18 (40.0)		
	40-49 Years	0 (0.0)	5 (11.1)		
	50-60 Years	3 (6.7)	2 (4.4)		
	Total	14 (31.1)	31 (68.9)	6.422	< 0.011*

Table 2 shows the Malaria Intensity in cases of co-infection by age and sex. Age shows a significant difference with p value of 0.039. In cases of high malaria cases (++), typhoid positive cases were detected the more. Overall, the patients who had high malaria intensity and co-infected with *Salmonella* were 68.9% of the total co-infection cases and those with low malaria intensity and co-infected with *Salmonella* were 31.1%. The overall p value stood at <0.011.

Table 3: Malaria Intensity in Typhoid Disease Cases

Malaria Intensity	***Salmonella***		**Chi square**	**P - value**	**Odds Ratio**
	Positive (%)	**Negative (%)**			
High	31 (26.3)	18 (15.3)	22.430	< 0.001*	6.766
Low	14(11.9)	55 (46.6)			

Table 3 displays the Malaria intensity in Typhoid Disease cases

The odds ratio compared the odds of an event occurring in one group to the odds of it occurring in another group.

Since when odds ratio =1 no association (exposure does not affect the odds of the outcome).

>1 is positive association (exposure is associated with higher odds of the outcome).

Hence, the above table displays that the individual with high malaria intensity has about 7 times higher odds (that is he is more likely) of developing typhoid fever compared to the individuals with low malaria intensity.

The chi-square and p value <0.001 shows positive association between malaria parasite infection and *Salmonella* infection.

DISCUSSION

Overall, greater percentage of the population had low to moderate parasite intensity representing about 75.3% when compared to the percentage with high density which stood at 24.7%. This reflects the period in which the result was conducted between February and May as more cases are recorded at the peak of rainy season.

According to a study by Tubosun et al., 2024 on 'Malaria and typhoid fever co-infection: a retrospective analysis of University Hospital records in Nigeria" The prevalence of co-infection peaked in May (9.7%), followed by June (8.9%) while April (5.7%). Also,

according to their study, it was notable that children aged 6 to 12 years exhibited the highest co-infection rate (18.5%), while those under five had the lowest (6.3%).

According to the results, younger age groups had more positive malaria cases and higher intensity (mono-infection an co-infection with typhoid) when compared to ages 40 and above and this is in consonance with World Health Organisation report which states that Africa's disproportionate load—94% of cases, 95% of deaths strikes children under 5 hardest (78% of regional fatalities). Nigeria (26.8%), the Democratic Republic of the Congo (12.3%), Uganda (5.1%), and Mozambique (4.2%) bore over half of global deaths (WHO, 2022). This could be attributable to younger age group of 13 to 39 being active and engaging more in outdoor activities which could expose them to more mosquito bites.

The result showed that in case of co-infection with typhoid (*Salmonella* infection), malaria intensity was higher at 26.3% when compared to the high intensity in case of mono-infection (malaria alone) at 15.3% (p value <0.001). The low parasite intensity cases had smaller percentage of co-infection at 11.9%.The odds ratio of 6.766 implies that individual with high malaria intensity has about 7 times higher odds (that is he is more likely) of developing typhoid fever compared to the individuals with low malaria intensity.

CONCLUSION

The elevated malaria parasite density in co-infected patients indicates that healthcare providers should maintain heightened vigilance for severe malaria presentations in patients with concurrent typhoid infection. This finding supports the implementation of more aggressive monitoring and treatment protocols for co-infected patients and public health awareness on vector control programs and increased sanitation.

Recommendations

The high prevalence rates necessitate comprehensive public health interventions including:

1. Improved laboratory capacity for accurate pathogen identification.

2. Comprehensive malaria vector control programs targeting breeding sites and transmission pathways.

3. Enhanced sanitation infrastructure to reduce typhoid transmission.

4. Development of integrated screening and treatment protocols for high-risk populations.

5. Vaccine should be made available by Government and stakeholders as preventive measures for both infections.

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