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Prevalence of malaria and typhoid fever co-infection among pregnant women attending antenatal clinic in Anyigba, Kogi State, Nigeria

Martin-Luther Okolo [1], Kikelomo Adeshina [1], Cornelius Omatola [*1], Idache Mudi [2], Eleojo Ugbane [3]

1- *Department of Microbiology, Kogi State University, Anyigba, Kogi State, Nigeria.*
2- *Department of Human Kinetics and Health Education, Kogi State University, Anyigba, Nigeria.*
3- *Federal Medical Center, Lokoja, Nigeria.*

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ABSTRACT

Background: Malaria and typhoid fever are among the most common infectious diseases in Nigeria and other developing countries where opportunities for transmission are wide-ranging. In pregnancy, concurrent infection by malaria and typhoid fever has significant clinical and public health implications such as spontaneous abortion and mortality. This study determined the prevalence of malaria, typhoid fever co-infection, and socio-demographic determinant among pregnant women attending antenatal clinics in Anyigba, Kogi State. **Method:** Blood samples from 100 consented pregnant women were screened for malaria parasite using CareStart rapid malaria diagnostic test kit and Giemsa-stained thick film microscopy while typhoid fever etiology was assessed using a commercial Widal agglutination test kit. **Result:** Of the 100 pregnant women screened, 19(40%) had malaria, 23(47%) had typhoid fever and 6(13%) had co-infection. Prevalence of malaria in pregnant women was high in the age group 25-29 years 10(52.6%), trader 7(36.8%), secondary education 8(42.1%), and people from rural areas 12(63.2%). Similarly, a high prevalence of typhoid was found among ages 25-29years 9(39.1%), traders 13(56.5%), secondary education 15(65.2%), and rural residents 16(69.6%). Also, co-infection was high among women with age 25-29 years 2(33.3%), trader 3(50%), secondary education 3(50%), and women from rural areas 4(66.7%). However, neither malaria, typhoid nor their co-infection was significantly associated with any of the above factors (p>0.05). Similarly, putative risk factors such as (residential areas with bushes, stagnant water, use of mosquito net or spray, source of drinking water, and food intake) were not significantly associated with the infections (p>0.05). **Conclusion:** Findings from the current study suggest both malaria and typhoid remain a disease of public health concern in pregnancy in the study area. Considering the adverse effects of both diseases on pregnancy and associated sequelae, there is a need for more efforts toward its prevention, control, and management.

Introduction

Malaria is caused by the parasite *Plasmodium* which spreads to humans through the bite of an infected female anopheles mosquito. There are five types of *Plasmodium* (*P.*

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* *Corresponding author:* Cornelius Omatola
E-mail address: omatolac@gmail.com

falciparum, P. ovale, P. malariae, P. vivax, and *P. knowlesi*). *Plasmodium falciparum* is the deadliest and affects the lives of almost 40 percent of the world's population with pregnant women and children under five years of age being the most affected [1]. Fifty percent of pregnant women were estimated to be carrying malaria parasites in their placenta without even experiencing malaria signs/symptoms and this development was reported to be responsible for twenty percent of stillbirths and 11 percent of all maternal deaths [2].

Malaria infection is considered a major threat to the lives and well-being of pregnant women and infants. In sub-Saharan Africa, 20 percent of pregnant women attending antenatal clinics tested positive for the malaria parasite, particularly *Plasmodium falciparum* [3]. Effects of malaria infection on pregnant women include; spontaneous abortion, maternal anemia, placental pathologies, infant mortality and morbidity, intra-uterine growth retardation, and low birth weight. Other effects include threatened abortion, miscarriage, and premature delivery weight which all have serious public health implications for the mother, the fetus, and the newborn [4]. Most cases of malaria in pregnancy in areas of stable malaria transmission are asymptomatic. This is attributed to anti-disease immunity acquired during previous exposures which protect against Clinical malaria [5]. Unfortunately, this subclinical infection still poses a great danger to both the mother and the fetus. The principal impact of malaria infection is due to the Pressure of the parasite in the placenta causing maternal anemia (potentially responsible for maternal death) when the case is severe, it results in Low Birth Weight (LBW) [6].

Typhoid fever, caused by *Salmonella typhi*, remains an important worldwide cause of morbidity and mortality and continues to be a health problem in developing countries where there is poor sanitation, poor standard of personal hygiene, and prevalence of contaminated food [7]. Typhoid fever is an enteric systemic infection caused by *Salmonella* spp., usually from ingestion of contaminated food or water. The acute illness is characterized by prolonged fever, headache, nausea, loss of appetite, and constipation or sometimes diarrhea. Symptoms are often non-specific and clinically non-distinguishable from other febrile illnesses. However, in some cases, infection leads to serious complications or even death. Poor sanitation and especially a lack of clean drinking water contribute to the incidence of infection. According to the most recent estimates, between 11 and 21 million cases and 128 000 to 161 000 typhoid-related deaths occur annually worldwide [8].

Co-infection of malaria and typhoid fever among pregnant women is a major concern because the treatment options may pose threat to the health of the fetus and may mean the same thing as not treating the infection. Hence, co-infection of malaria and typhoid in pregnant women is a medically delicate condition. Specifically, for pregnant women, infection occurs due to lowered immunity. This is because two individuals are obtaining nutrients from a single mother that is, the mother herself and the fetus in the uterus [9]. Mounting control measures against both malaria and typhoid fever among pregnant women via control of mosquito bites and provision of clean, potable water, avoidance of contaminated food, becomes the safest option to prevent malaria and typhoid co-infection [10].

The co-infection of the malaria parasite and *Salmonella* species is common, especially in the tropics where malaria is endemic. The common detection of high antibody titer of these *Salmonella* serotypes in malaria patients has made some people believe that malaria infection can progress to typhoid or that malaria always co-infects with typhoid/paratyphoid in all patients [11]. Hence some people treat malaria concurrently once they have high antibody titer for *Salmonella* serotypes even without adequate laboratory diagnosis for malaria and vice versa. This study was aimed at determining the prevalence of malaria and typhoid fever co-infection among pregnant women attending Maria Goretti Hospital Anyigba, Kogi State

Methods

Study area

The study was carried out among pregnant women attending antenatal care in Maria Goretti Hospital, Anyigba. Anyigba is a town in Dekina Local Government Area in Kogi State located between Latitude 7o15'N-7o29'N and longitude 7o11'E - 7o32'E. With an average altitude of 385m above sea level and a total land mass area of 420Sq.km2 has an estimated population of 189,976 people. The indigenes are predominantly Igala by tribe [12].

Study population

The study population comprised 100 pregnant women who were attending antenatal care at Maria Goretti Hospital, Anyigba, Kogi State between

June-July, 2022. The inclusion criteria include pregnant women attending antenatal care in Anyigba, Dekina Local Government Area of Kogi State, who consented to the study and were present in the hospital on the sampling day. The exclusion criteria include pregnant women who weren't attending antenatal care, women who are not pregnant, pregnant women who did not consent to participate in the study, and those who were absent from the hospital on the sampling day.

Ethical consideration

Ethical permission was gotten from the Medical Officer of Health (MOH), Dekina Local Government, Kogi State. Approval was requested from the management of hospitals where the pregnant women attended antenatal, the consent of the women was requested and questionnaires were administered to those who consented to participate in the study.

Sample collection and laboratory assays

Two (2) mL of blood samples were obtained from each of the 100 consented pregnant women by venipuncture into a properly labeled specimen bottle. One (1) mL aliquots of the blood were spun at 3000rpm (2500xg) for 8 to10 seconds to separate serum for malarial parasite serology. The aliquot remaining was used for widal agglutination assays. The rapid diagnostic test kit (Care StartTM Malaria HRP2, G0141, Cat. No. D21M0) was employed for initial screening for the malaria parasite. The Care Start immuno-assay kit targets the histidine-rich proteins of *P. falciparum* in blood specimens by employing an antibody-antigen reaction. Further, Giemsa-stained thick and thin blood films were performed following the method described by Cheesbrough [13]. Widal diagnostic test Kit (Rapid diagnostic, UK; Cat. No. HF-KIT8X5C) was employed for the Widal agglutination test based on the procedures previously described by Cheesbrough [13].

Statistical analysis

Statistical packages for social sciences (SPPS) were used to analyze data obtained in the study. Chi-square (X2) was used to assess the level of significance between variables and malaria and/or typhoid fever infection. p-value <0.05 was used to establish the level of statistical significance.

Results

Of the 100 pregnant women tested in this study, 19(40%), 23(47%), and 6(13%) were positive for malaria, typhoid fever, and co-infection, respectively **(Figure 1).** Generally, women aged 25-29 years had a higher prevalence of single (malaria, 52.6%; typhoid fever, 39.1%) and Dual (malaria+typhoid fever, 33.3%) infection than the other age categories. Though, the ages of infection were neither significantly related to malaria nor typhoid fever occurrence (p>0.05) **(Table 1).** Concerning trimester, single infection was higher in the second trimester (malaria, 47.4%; typhoid fever, 47.8%) than other gestational levels while co-infection which accounts for 50% was higher among women in their first trimester than other levels **(Table 2)**. In terms of occupation, malaria and/ or typhoid fever were generally higher among women involved in traders (malaria, 36.8%; typhoid fever, 56.5%; Dual, 50%) compared to other occupations. Also, those women with secondary as the highest level of education had 42.1%, 65.2%, and 50% prevalence of malaria, typhoid fever, and co-infection, respectively, which is higher than in other levels of education. Further, Rural dwellers with 63.2%, 69.6%, and 66.7% prevalence of malaria, typhoid fever, and co-infection, respectively, were more predisposed to infections than urban dwellers **(Table 3).** However, neither level of education, trimester, occupation nor residence of participants was significantly related to malaria and/ or typhoid fever positivity (p>0.05). Mosquito net/spray use in places where stagnant water and bushes are common is generally associated with lower malaria prevalence in women than in those who don't use the preventive measure **(Table 4)**. Also, Women who patronize food outside had more typhoid fever (Prevalence, 56.5% vs 43.4). With respect to the source of drinking water, pregnant women who source water from boreholes had a higher prevalence of 8(34.8%) of typhoid fever as compared to those that drink from well 6(26.1%), river 5(21.7%) and sachet or bottle water 4(17.4%). Again, women who lack awareness about infection or the control had a 43.4% prevalence of typhoid fever against 21.7% and 34.8% observed in other women with certain degrees of awareness. Though, none of the risk factors investigated was statistically associated with malaria or typhoid fever **(Table 5).**

Table 1. Seroprevalence of malaria, typhoid and co-infection among pregnant women in relation to age.

Age group	Number examined	Number positive (%) to malaria parasite	Number positive (%) to typhoid	Number positive (%) to co-infection	X^2	*p*-value
20 - 24	19	2 (10.5)	6 (26.1)	2 (33.3)	2.940	0.8164
25 - 29	41	10 (52.6)	9 (39.1)	2 (33.3)		
30 - 34	29	4 (21.1)	3 (13.0)	1 (16.7)		
35 - 39	11	3 (15.8)	5 (21.7)	1 (16.7)		
Total	100	19	23	6		

Chi Square = X2, Probability value = p-value, Confidence Interval = 95%.

Table 2. Seroprevalence of typhoid and co-infection among pregnant women in relation to trimester.

Trimester	Number examined	Number positive (%) to malaria parasite	Number positive (%) to typhoid	Number positive (%) to co-infection	X^2	*p*-value
First	18	4 (21.1)	5 (21.7)	3 (50.0)	2.323	0.6767
Second	50	9 (47.4)	11 (47.8)	2 (33.3)		
Third	32	6 (31.6)	7 (30.4)	1 (16.7)		
Total	100	19	23	6		

Chi Square = X^2, Probability value = *p*-value, Confidence Interval = 95%.

Table 3. Seroprevalence of malaria, typhoid and co-Infection among pregnant women in relation to socio-demographical factors.

Variables	Number examined	Number positive (%) to malaria parasite	Number positive (%) to typhoid	Number positive (%) to co-infection	X^2	*p*-value
Occupation						
Civil Servant	25	5 (26.3)	4 (17.4)	1 (16.7)	1.697	0.7913
Trader	43	7 (36.8)	13 (56.5)	3 (50.0)		
House wife	32	7 (36.8)	6 (26.1)	2 (33.3)		
Educational status						
Primary	16	4 (21.1)	2 (8.7)	1 (16.7)	2.720	0.6058
Secondary	49	8 (42.1)	15 (65.2)	3 (50.0)		
Tertiary	35	7 (36.8)	6 (26.1)	2 (33.3)		
Residential Area						
Urban	39	7 (39)	7 (30.4)	2 (33.3)	0.1992	0.9084
Rural	61	12 (63.2)	16 (69.6)	4 (66.7)		

Chi Square = X^2, Probability value = *p*-value, Confidence Interval = 95%

Table 4. Seroprevalence of malaria among pregnant women in relation to some risk factors.

Variables	Number Examined	Number Positive (%)		*p*-value
Residential Areas with Bushes Using Mosquito Net or Spray				
Yes	40	2 (10.5)		0.4296
No	26	11 (57.9)		
Residential Areas without Bushes Using Mosquito Net or Spray				
Yes	21	2 (10.5)		0.3179
No	13	4 (21.1)		
Residential Areas with Stagnant Water Using Mosquito Net or Spray				
Yes	24	1 (5.3)		0.5289
No	15	8 (42.1)		
Residential Areas without Stagnant Water Using Mosquito Net or Spray				
Yes	32	1 (5.3)		0.2763
No	29	9 (47.4)		

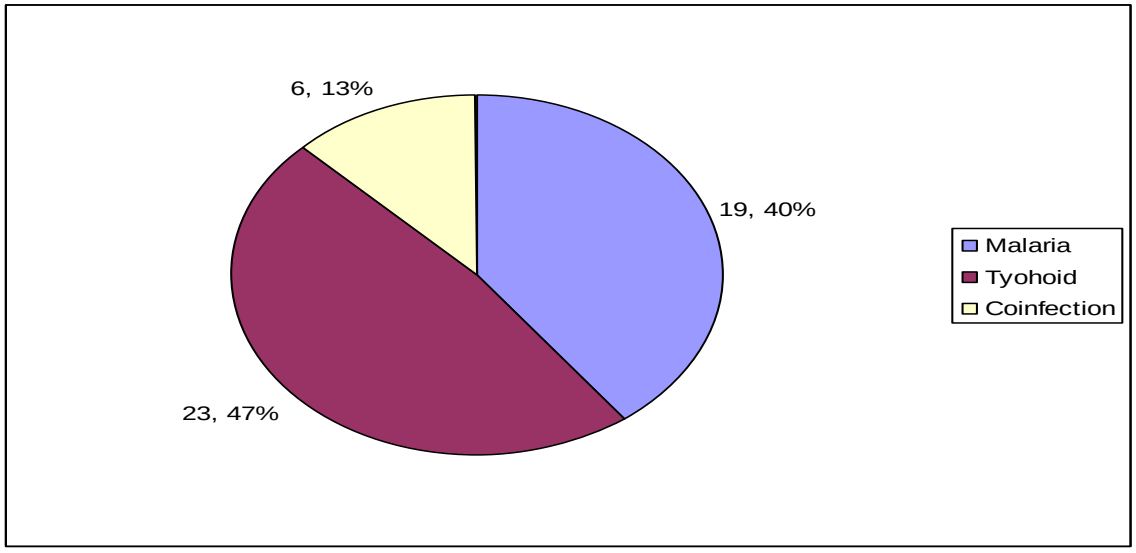
Probability value = *p*-value, Confidence Interval = 95%

Table 5. Seroprevalence of typhoid fever among pregnant women in relation to some risk factors.

Variables	Number examined	Number positive (%)	X^2	*p*-value
Source of Drinking Water				
Borehole	47	8 (34.8)	7.367	0.0611
Well	17	6 (26.1)		
River	10	5 (21.7)		
Sachet Water	26	4 (17.4)		
Source of Food Intake				
Cook by Oneself	57	10 (43.4)	3.550	0.0596
Buy Outside	47	13 (56.5)		
Food and Hand Washing Precaution				
Religiously	32	5 (21.7)	2.477	0.2898
Quite Often	68	18 (78.3)		
Not at all	0	0 (0.0)		
Awareness Level				
Very Informed	19	5 (21.7)	0.2022	0.9039
Quite Informed	45	8 (34.8)		
Not at all	36	10 (43.4)		

Chi Square = X^2, Probability value = *p*-value, Confidence Interval = 95%.

Figure 1. Seroprevalence of malaria, typhoid and co-infection among pregnant women attending Maria Gorretti Hospital Anyigba.



Discussion

Malaria and its co-infection with typhoid fever is a major public health problem in pregnant women in Nigeria. In the current study, the malaria prevalence rate of 19(40%) observed among pregnant women in Anyigba is higher than the 32.7% earlier reported among pregnant women in the area [14] and 22% and 28.8% seroprevalence rates reported elsewhere in the states [15,16], an indication suggesting high endemic transmission of malaria in this region. Contrary to our findings, **Pam et al.** [17] and **Sohail et al.** [18] also reported lower malaria prevalence of 8.0% and 5.4% among pregnant women in Abuja and India, respectively. Although, the malaria prevalence rate of 65.9% higher than the rate observed in our study had been reported among pregnant women in Lagos [19]. The variation in the prevalence rate of malaria observed in this study may be due to the different environmental factors existing in the area where the study was conducted. The level of environmental sanitation, as well as the state of infrastructural development, may vary between the different study locations, thus, causing a difference in the level of malaria transmission and infection. Although, there was no significant association between age and infection with malaria parasite in this study. Pregnant women within the age range of 25-29, 10 (52.6%) were more infected than other age groups. This agrees with the reports of **Orok et al.** [20] and **Pam et al.** [17] who also reported a higher prevalence of malaria in the age range of 25-30 years. The high rate in this age group might be explained by a greater tendency for outdoor activities which is associated with increased mosquito bites. Generally, there was a decline in malaria infection with advancing age which could be attributed to the accumulation of natural immunity in older adults due to repeated exposure to the malaria parasite. As previously observed in the area[15], mothers of increased age are likely more exposed to health services and awareness about malaria than the younger ones.

This study generally observed higher malaria prevalence among women with higher educational levels than those with primary qualifications. These findings contradict the study of **Haruna et al.** [21] who reported a higher prevalence of malaria among nonformal education (32.8%), followed by those with primary education (28.7%), followed by those with secondary education (28.4%), and those with tertiary education had the least prevalence (15.8%). It also contradicts the work of **Omoya et al.** [19] in a study among pregnant women in Lagos which had a similar result. They hypothesized that parasitic infection decreases progressively with an increase in educational status. Individuals with the tertiary institution are regarded as educated and informed and are therefore expected to have some level of awareness about malaria including its preventive measures. Similarly, occupation was not significantly associated with the infection of malaria parasites in this current study. Nevertheless, housewives 7(36.8%) and traders 7(36.8%) had a higher prevalence of the infection compared to civil servants 5(26.3%). This report is similar to the work

of **Haruna et al.** [21] who recorded a higher prevalence of malaria among housewives (30.9%) compared to traders (17.7%) and civil servants (8.3%). This is expected because financial status has previously been linked with malaria [22] as poverty is associated with overcrowding and poor hygienic and sanitary conditions. The result could be attributed to the nature of the environment of the traders which exposes them to bites of the vectors of malaria.

The findings of higher malaria parasitemia in pregnant women in their second trimester (47.4%) than those in the first 4(21.1%) and third trimester 6(31.6%), though consistent with the previous observation in other parts of the state [14,16], is not clear, as constant intermittent preventive treatment given to women during antenatal care visit has been correlated with a decline in maternal malarial burden in higher trimesters [23].

In the current study, lack of mosquito net/spray use is related to higher malaria prevalence than the use of mosquito net/spray. These findings support the work of **Simon et al.** [24], who reported that those that did not use mosquito nets or spray had the highest prevalence and also agreed with the work of **Otina et al.** [25], who reported the use of mosquito net/spray as a good preventive measure for malaria parasite. The high malaria prevalence observed among pregnant women with stagnant water around their houses as compared to those without it suggests stagnant water plays a role in malaria vector abundance which has been shown to influence rates of predisposition to the parasite in the area [26]. Our findings correlate with the work of **Belete and Roro** [27] who reported lower malaria prevalence among those who do not live around stagnant water.

The typhoid fever prevalence of 23(47%) among pregnant women in this study is higher than the 17.5% seropositivity rate earlier reported in another part of the state [28]. The reduction of cellular and humoral immunity which occur during pregnancy [29] may increase the rate of susceptibility of pregnant women to infection such as typhoid fever. Various prevalent rates of malaria and typhoid co-infection have been reported in the general population [30]. The result is lower than the report of most studies conducted in Nigeria. For instance, it was 43% among pregnant women in Abuja [17], 49.4% among adults in Ebonyi [31], 67.1% among pregnant women in Lagos [19] and higher (7.7%) than the report of **Haruna et al.** [21]. The lower prevalence of the bacteria infection recorded in this study may be because the majority of the participant was from an urban area and may be living in a hygienic environment and drinking safe water.

Despite the age of pregnant women in this study was not statistically associated with the prevalence of typhoid fever, the study still found a high rate of predisposition to typhoid fever in ages 25-29 years 9(39.1%), which does not agree with the work of **Orok et al.** [20] who reported higher prevalence among age 31-40 years among pregnant women in Calabar. Nevertheless**, Odikamnoro et al.** [31] reported a higher prevalence of the infection among subjects aged 40-60 years. The higher prevalence of typhoid fever observed among the aged 25-29 years in this study may be attributed to the engagement of younger women particularly in this part of the world in house chores such as washing toilet, and bathroom and taking care of babies which may put them at risk of infection.

About Educational status, more infection of typhoid fever occurs among women with a secondary level of qualification compared to other educational levels. This result contradicts the work of **Haruna et al.** [21], who recorded a high prevalence among primary school level 21(9.7%). Concerning occupational status, a higher prevalence was recorded in this study among traders 13(56.5%). This result in not in agreement with the work of **Haruna et al.** [21] who reported a higher prevalence among housewives. Outdoor exposure associated with trading may partly explain the greater predisposition of women to typhoid fever than some of the occupational status investigated.

According to the residence, pregnant women living in rural area 16(69.6%) has the highest prevalence of typhoid fever than those from urban area 7(30.4%). This result agreed with the report of **Haruna et al.** [21] who had a high prevalence of the infection among pregnant women from rural areas (18.8%) than those from urban areas (6.3%). This is because most Nigerian rural communities are associated with a lack of basic and social amenities, extreme poverty, and poor sanitary condition. This result also supports other previous studies conducted in rural communities which reported a higher prevalence of the infection in a rural areas [31].

The study further showed that the rate of malaria-typhoid co-infection among the pregnant women attending the study area was 6(13%), lower

than 9.0% reported among pregnant women in Abuja [17] and 28.0% among pregnant women in Calabar [20]. Furthermore, malaria-infected pregnant women are said to be more susceptible to typhoid co-infection because of the increased hemolysis which takes place in *Plasmodium falciparum* infection and the deposition of iron in tissue especially the liver. *Salmonella* spp. has been reported to strive better in iron-rich tissues such as exists in malaria [32].

Malaria-typhoid co-infection was not associated with age, educational status, and occupation in this study. However, a higher prevalence was recorded among younger pregnant women of age 20-24 years with secondary education and who were traders. This result is similar to the work of **Haruna et al.** [21] who recorded a higher prevalence among young pregnant women of age ≤20 3(3.5%) with primary education (3.2%) and who were traders (3.9%). This may be because the transmission of malaria and typhoid fever is affected by factors such as environmental sanitation, level of education, and socio-economic status. Additionally, the residential area was not significantly associated with malaria/typhoid co-infection in this study (p=0.9084) as higher prevalence was recorded among those from rural area 4(66.7%) than those from urban area 2(33.3%) compared with the work of **Haruna et al.** [21] who had 6.3% among pregnant women from a rural area and 2.4% among pregnant women from urban area. This is expected because most previous researchers [33,34] linked malaria/typhoid to poor sanitary conditions, inadequate safe water supply, and low financial status and these are common features of typical Nigerian rural communities.

In conclusion, the present study revealed that both malaria and typhoid fever remain diseases of concern among healthy pregnant women in the study area. Therefore, to reduce the burden of malaria and/ or typhoid fever in the area, strategies for the prevention and control of malaria during pregnancy 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 such as the consistent use of insecticide-treated nets.

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References

1-**Akinwusi PA, Komolate AO, Olayemi OO, Adeomi AA.** Communicable diseases related sudden death in the 21 century in Nigeria. Infectious Drug Resistance 2013; 6: 125-132

2-**Ubandoma A, Awache I, Ebuara FU.** Prevalence of malaria and typhoid fever co-infection and the hematological profile of patients attending hospitals in Wukari, Taraba State, Nigeria. AASCIT Journal of Bioscience 2017; 3(6): 79-86

3-**Essa F, Hussain ZM, Batool D, Usman A, Takoob U.** Study of sociodemographic factors affecting the prevalence of typhoid. Annual of Medical and Health Science Research 2019; 9: 469-471.

4-**Steele DA, Burges DC, Diaz Z, Cary ME, Zaidi KMA.** Challenges and opportunities for typhoid fever control: A call for coordinated action. Clinical infectious Diseases 2016; 62: 54-58.

5-**Martinez-Perz G, Lansana DP, Omoonga S, Guta H, Breeze Barny B, Gonzalez R.** A prevalence of Plasmodium falciparum infection among pregnant women at first Antenatal visit in post Ebola Monrovia, Liberia. Malaria Journal 2018; 17: 357.

6-**Berry L, Walker P, Tagbor H, Bojang K, Coulibaly SO, Kayentaok T.** Seasonal Dynamics of malaria in pregnancy in West Africa: evidence for carriage it infectious acquired before pregnancy until first contact with antenatal care. AM Trop med gy. 2018; 98: 534-42.

7-**Alnwich D.** Meeting the malaria challenge. American Journal Trop Med Hyg. 2010; 74: 108-113.

8-**Budd W.** Typhoid fever, its nature, mode of spreading and prevention in London. Typhoid fever. Am J Public Health 1918; 8(8):610-2.

9-**Bardají A, Bassat Q, Alonso PL, Menéndez C.** Intermittent preventive treatment of malaria in pregnant women and infants: making best use of the available evidence. Expert opinion on pharmacotherapy 2012; 13(12): 1719-1736.

10-**Enyuma COA, Meremikwu MM, Udo JJ, Anah MU, Asindi AA.** Malaria parasite positivity among febrile neonates. Nigerian Journal of Paediatrics 2014; 41(4): 321-325.

11-**Williams JE, Cains M, Njie F, Large A, Quaye S, Anine T, et al.** The performance of a rapid diagnostic test in detecting malaria infectious in pregnant women and the impact of misdiagnosed Infections. Common infectious Disease 2012; 62: 837-844

12-**Omatola CA, Onoja AB, Moses E, Mahmud M, Mofolorunsho CK.** Dengue in parts of the Guinea Savannah region of Nigeria and the risk of increased transmission. International Health 2021; 13(3): 248–252.

13-**Cheesbrough M.** District laboratory practice in Tropical countries. Part1. 2 nd , Edition, Publisher Cambridge University Press, 2005; Pp. 239-258

14-**Okolo MO, Omatola CA, Ezugwu AI, Adejo PO, Abraham OJ, Chukwuma OJT.** Prevalence of Malaria among Pregnant Women attending Antenatal clinic in Grimard Catholic Hospital, Anyigba in Kogi State, Nigeria. Nat Sci 2017;15(9):113-117.

15-**Omatola CA, Okolo MO.** Hepatitis B and Asymptomatic Malaria Infection among Pregnant Women in a Semiurban Community of North-Central Nigeria. Journal of environmental and public health, 2021, 2021(2):1-7. ID: 9996885.

16-**Mofolorunsho CK, Audu HO and Omatola CA.** Prevalence of Malaria among Pregnant Women attending a Healthcare Facility in Lokoja, North-Central, Nigeria, Asian Journal of pharmaceutical and health sciences 2013; 4(2):936-9.

17-**Pam VA, Landan S, Adejoh VA, Pam DD, Danjuma K.** Co-infection of malaria and typhoid fever among pregnant women attending antenatal clinics at General hospital, Wuse, Federal Capital Territory (FCT), Abuja, Nigeria. Nigerian Journal of Parasitology 2018; 39(2): 148-153.

18-**Sohail M, Shakeel S, Kumari S, Bharti A, Zahid F, Anwar S, et al.** Prevalence of malaria infection and risk factors associated with anaemia among pregnant women in semiurban community of Hazaribag, Jharkhand, India. BioMed Research International 2015; 2015:740512.

19-**Omoya FO.** Co-infection of malaria and typhoid fever among pregnant women attending primary health care centre, Ojo Local Government, Lagos, Nigeria. Health Science Journal 2017; 11(2): 20-25

20-**Orok DA, Usang AI, Ikpan OO, Duke EE, Eyo EE, Edadi UE, et al.** Prevalence of malaria and typhoid fever co-infection among febrile patients attending college of health technology medical centre in Calabar, Cross River state, Nigeria. International Journal of Current Microbiology and Applied Science 2016; 5(4): 825-835

21-**Haruna IM, Idris MM, Hussaini AS.** Malaria and typhoid fever: Prevalence, Co-infection and socio-demographic determinant among pregnant women attending antenatal care at a primary health care facility in Central Nigerial. International Journal of Pathogen Research 2020; 5(4): 17-24.

22-**World Health Organization.** Meeting of the Strategic Advisory Group of Experts on Immunization, October 2017—conclusions and

recommendations. Weekly Epidemiological Records. 2017. 92: 729–4734

23-**Nosten F, ter Kuile FO, Maelankirri L, Decludt B, White NJ.** Malaria during pregnancy in an area of unstable endemicity. Trans. Res. Soc. Trop. Med. Hyg. 1991:85: 424 429.

24-**Simon-Delso N, Amaral-Rogers V, Belzunces LP, Bonmatin JM, Chagnon M, Downs C, et al.** Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. Environmental Science and Pollution Research 2015; 22(1): 5-34.

25-**Otina O, Kara H, Julia, F.** Inequalities in purchasing of mosquito nets and willingness to pay for treated nets in Nigeria: challenges for Malaria control intervention. Malaria Journal. 2004; 3:6.

26-**Omatola CA, Onoja BA, Fassan PK, Osaruyi SA, Iyeh MI, Samuel MA, et al.** Seroprevalence of Chikungunya virus infection in five hospitals within Anyigba, Kogi State of Nigeria. Brazilian Journal of Infectious Diseases 2020; 24(1):1–6.

27-**Belete EM, Roro AB.** Malaria Prevalence and Its Associated Risk Factors among Patients Attending Chichu and Wonago Health Centres, South Ethiopia. Journal of research in health sciences 2016; 16(4):185-189.

28-**Oseni OML, Omatola CA, Samson SO, Idache BM.** Evidence of hepatitis B infection and co-infection with enteric fever among febrile patients in a primary health facility in Kogi State, Nigeria. J Immunoassay Immunochem 2022;43(5):516-525.

29-**Udoidung NI, Eyoh EE.** Prevalence of Co-Infection of Malaria and Typhoid in Pregnant Women in Uyo, Akwa Ibom State, Nigeria. World Journal of Applied Science and Technology 2015; 7: 89-97.

30-**Isibor JO, Igun E, Okodua M, Akhite AP, Isiobor E.** Co-infections with malaria parasite and Salmonella typhi in patients in Benin City, Nigeria. Ann Bio Res 2011; 2(2): 361 - 365.

31-**Odikamnoro OO, Ikeh IM, Okoh FN, Ebiriekwe SC, Nnadozie IA, Nkwuda JO, et al.** Incidence of malaria/typhoid co-infection among adult population in Unwana community, Afikpo north local government area, Ebonyi state, Southeastern Nigeria. African journal of infectious diseases 2017; 12(1): 33-38.

32-**van Santen S, de Mast Q, Swinkels DW, van der Ven AJ.** The iron link between malaria and invasive non-typhoid Salmonella infections. Trends in parasitology 2013; 29(5), 220–227.

33-**Crump J A, Luby SP, Minitz ED.** The global burden of typhoid fever. Bull World Health Organization 2014; 82(5): 346-353.

34-**Wain J, Hendriksen RS, Mikoleit ML, Keddy KH, Ochiai RL.** Typhoid fever. Lancet 2015; 385(9973): 1136-1145.