

Co-Infection Of Typhoid And Malaria Fevers Among The Inhabitants Of A Sub-Urban Community In The Southeastern Nigeria

Onyido AE¹, Okafor AC¹, Chikezie FM^{2#}, Egbuche CM¹, Umeanaeto PU¹, Okafor EN³, Ezihe EK^{1,2}, Iwueze MO¹, Ogbonna CU⁴, Anumba JU^{1,2}.

¹Department of Parasitology and Entomology, Faculty of Biosciences, Nnamdi Azikiwe University Awka, Anambra State, Nigeria. ²Federal Ministry of Health, National Arbovirus and Vectors Research Centre, Enugu, Nigeria.

³Department of Chemical Pathology, University of Nigeria Teaching Hospital, Ituku Ozalla, Enugu, Nigeria.

⁴Department of Biology/Microbiology/Biotechnology, Federal University Ndufu-Alike Ikwo, Abakaliki, Ebonyi State, Nigeria.

Authors' email addresses: ae.onyido@unizik.edu.ng, okaforafamc@yahoo.com, meetfridayonline@yahoo.com, chukwudieguche@yahoo.com, mumamaka@yahoo.com, okaforen@yahoo.com, eziheebuka@yahoo.com, mirobiukwu@yahoo.com, dollarsquare@gmail.com, anumbajoe@gmail.com

Abstract: A study aimed at determining the prevalence and co-infection of malaria and typhoid fevers was carried out in Ukpok community, Nnewi South Local Government Area, Anambra State, Nigeria. Biodata of the participants were obtained through oral interviews while malaria and typhoid fevers were diagnosed using venous blood samples collected from apparently healthy individuals who did not show any signs and symptoms of malaria and typhoid fevers. Field-stained thick and thin blood films were used to detect malaria parasites in the samples. Typhoid fever was diagnosed from the blood samples of the participants using Febrile Diagnostic Test Kit (FDTK) containing the O and H antigens for *Paratyphi* A and C, and the *Typhus* D. A total of 155 participants composed of 42 males and 113 females were examined. 64 (41.7%) tested positive for malaria, 60 (38.0%) were positive for typhoid fever and 40 (25.0%) were co-infected with malaria and typhoid. There was no significant difference in co-infection of malaria and typhoid fevers among the gender groups ($\chi^2 > 0.05$), though males had higher infection (30.9 %) than the females (17.4 %). There were significant differences in malaria and typhoid co-infections among the villages, age, education and occupational groups ($\chi^2 < 0.05$). Location, age, education and occupational groups were considered important predisposing factors of infections with typhoid and malaria fevers. Improved environmental sanitation, personal hygiene, reduction of breeding sites of malaria vectors and houseflies and health education of the people were suggested to check the transmission of malaria and typhoid in the community.

[Onyido AE, Okafor AC, Chikezie FM, Egbuche CM, Umeanaeto PU, Okafor EN, Ezihe EK, Iwueze MO, Ogbonna CU, Anumba JU. **Co-Infection Of Typhoid And Malaria Fevers Among The Inhabitants Of A Sub-Urban Community In The Southeastern Nigeria.** *Nat Sci* 2015;13(12):47-56]. (ISSN: 1545-0740).

<http://www.sciencepub.net/nature>. 7. doi:[10.7537/marsnsj131215.07](https://doi.org/10.7537/marsnsj131215.07).

Keyword: Typhoid fever, malaria, co-infection, personal hygiene.

Introduction

Malaria and typhoid are among the most endemic diseases in the tropics. Both diseases have been associated with poverty and under-development with significant morbidity and mortality (Sachs and Malaney, 2002; Smith, 1982).

Typhoid fever also known as enteric fever is an acute systemic infection caused by bacteria of the genus *Salmonella*, including *Salmonella typhi* and *S. paratyphi*. These are Gram-negative, aerobic, non-spore forming and rod-shaped bacteria (Lucas and Gilles, 2007; WHO, 2003). It is a water and food-borne infection transmitted principally through the ingestion of food or water contaminated with infected sewage. Typhoid fever has a worldwide distribution but is endemic in communities where the standards of sanitation and personal hygiene are low (Lucas and Gilles, 2007). The illness is common in many countries

of the world where there are poor sanitation, especially where poor hand washing or good hygiene standards are not adequately practiced (CDC, 2008; CDC, 2009). An estimated 12-33 million cases of typhoid fever occur globally each year, and the disease is endemic in many developing countries of the Indian subcontinent, South and Central America and Africa. Outbreaks have equally occurred in Europe. In endemic countries, it reduces attendance to work, keeps children out of schools, reduces productivity and income among other economic effects (WHO, 2003).

On the other hand, malaria is caused by four species of the protozoan parasite belonging to the genus *Plasmodium*. These are *P. falciparum*, *P. vivax*, *P. ovale* and *P. malariae*, with the first and second causing the greatest morbidity, while *P. falciparum* causes the greatest mortality associated with malaria (WHO, 2008). It is transmitted to man through the bites

of infected female *Anopheles* mosquitoes. Globally, malaria caused an estimated 219 (range 154–289) million cases and 660 000 (range 490 000–836 000) deaths in 2010. Approximately 80% of the cases and 90% of the deaths occur in Africa while the remaining cases and deaths are mainly in the South-East Asia and Eastern Mediterranean Regions (WHO, 2012). It remains an important public health parasitic disease in both tropical and subtropical countries in Africa, where it is mostly seasonal with its major incidence occurring in the rainy season (Eneanya, 1998; Oesterholt *et al.*, 2006).

Malaria and Typhoid fevers are common in many countries of the world where the prevailing environmental conditions, poor sanitation habits, poverty and ignorance abound, especially in Africa, Asia, South America and Australia. In the last two decades, the relationship between these two diseases has been substantiated by studies from Africa and India (Amma *et al.*, 1999). Their co-infection in an individual does not only grossly affect the health of the individual but maintains a vicious cycle of poverty and very low productivity in the community as well as posing serious economic burden on the society at large. This study was therefore aimed at determining the prevalence and co-infection of typhoid and malaria fevers in Ukpok community, Nnewi South L.G.A, Anambra State, Nigeria. We diagnosed malaria using microscopy and to diagnose typhoid using Febrile Diagnostic Test Kit (FDTK), determine the prevalence and co-infection of malaria and typhoid fever through clinical observations and calculation of appropriate indices as well as determine the groups (age, sex, occupational status, and level of education) mostly affected.

Materials and Methods

Study design

This was a cross-sectional survey of the residents of Ukpok community to determine the co-infection of typhoid and malaria fevers.

Study Area

The study was carried out in Ukpok community in Nnewi South L.G.A of Anambra State. Ukpok is the Headquarters of Nnewi South Local Government Area. It is located between 5° 56' N, 6° 50'E and Longitudes 6° 92'N, 5° 57'E. Ukpok is made up of approximately 8 villages namely: Agbuana, Ebe, Nzagha, Osigbu, Uboma, Umudike, Umunuko and Umuhama. It is bounded to the north by Ezinifite community, to the east by Ebenato, to the south by Ekwusigo Local Government Area and to the west by Nnewi North Local Government Area. It is about 35 km from Awka, the capital city of Anambra State. Ukpok is a tropical rain forest community with a lot of thick forests and trees. It has an annual humidity range of 70-86 %,

maximum temperature range of 27-36°C and a minimum temperature range of 20-30°C. It has about 9 months of rainfall (April-November), with annual rainfall range of 2000mm to 3000mm. The dry season lasts from December to March, with a short spell of cold dry period of harmattan between December and February.

The major occupations of the people are farming and petty trading. Majority are subsistent farmers practicing crop farming with keeping of goats, sheep, poultry and a few cows. Water supply in Ukpok is inadequate with the majority of the populace relying on streams and rainfall while very few have access to boreholes or wells. Ukpok has an undulating topography with many small hills alternating with valleys. The drainage system in the area is inadequate. Most of them are open gutters usually blocked with sand and refuse. The waste disposal system is also inadequate. Bush and open air defaecation is still a common practice. Household garbage are thrown out indiscriminately in nearby farm lands.

Community mobilization

The community was mobilized through advocacy visits to the traditional rulers, opinion leaders and church leaders with an introductory letter from the Head of the Department of Parasitology and Entomology, Nnamdi Azikiwe University, Awka, Nigeria. Informed consent of the participants was obtained after explaining the project intents. Consent for the screening of children was obtained from their parents, guardians or caregivers. Town criers, churches and schools were used for dissemination of information to the populace. Participants were assembled at the civic centre on the agreed dates.

Blood sample collection and preparation of blood films

Two milliliters of venous blood samples were collected from each participant, from which 3 drops of each sample were used to prepare thick and thin blood films for the identification of malaria parasites. The rest of each blood sample was placed in a clean test tube, and allowed to clot so as to separate the serum from other blood components. The serum was used for Widal agglutination test for typhoid fever.

Thick blood films were prepared by placing two large drops of each blood sample at the middle of grease-free dry microscope slide. The blood was spread in a circular motion using the edge of a spreader slide until it became translucent. Each blood film was properly labeled using pencil for easy identification. The films were allowed to air-dry on a slide rack protected from the flies and dust.

Thin blood films were prepared by placing a drop of each blood sample on a dry, clean, dust free and grease free slide. Placing a smooth age spreader at an angle of 45° to the horizontal slide, the drop of blood

was allowed to run along the flat edge of the spreader slide. The spreader was gently but firmly pushed along the horizontal slide. In each case, care was taken to ensure even contact of the spreader and the surface of the horizontal slide. The films were allowed to air-dry, on a slide rack, protected from flies and dust.

Staining of blood films

Water-based Romanowsky stain (Field's stains) was used to stain the slides. The thick blood films were not fixed but dipped directly into Field's Stain A for three seconds, washed gently by dipping into clean water, dipped into Field's Stain B for another three seconds, washed again in clean water and placed on a slide rack to air-dry before examination.

Thin blood films were fixed in absolute methanol for two minutes. Using a Pasteur pipette, the films were covered with Field stain B, an equal volume of Field stain A was added immediately and mixed thoroughly by tilting the slide. The films were then left to stain for one minute before gently washing off the stain with clean, running tap water. The slides containing the films were then placed in an upright position in a slide rack to drain and air-dry.

Microscopic examination of blood films

All the films were examined under the microscope using x100 objective (immersion oil objective). The results were recorded against the names and number of the participants. The intensity of malaria infections was recorded using the plus sign thus: mild infection (+): 1-10 parasites per 100 high power fields; moderate infection (++) : 11-100 parasites per 100 high power fields; heavy infection (+++): 100-1000 parasites per high power field (Cheesbrough, 2006).

Diagnosis of Typhoid fevers

Typhoid fever was diagnosed using Widal Test Kit. The reactants contain attenuated typhoid antigen which reacts specifically with the human antibodies. Febrile diagnostic test kits containing the O and H antigens for paratyphi A-C and typhus D respectively were used.

The clotted blood mass was removed from each blood component. The serum was emptied into a centrifuge tube and centrifuged for 5 minutes at 1200 revolutions per minute (RPM) to separate pieces of blood clot from the serum. A white tile was cleaned properly using cotton wool and a drop of normal saline placed on it. A drop of each reactant was placed in the following progression: Paratyphi A,B,C and typhus D of O antigen in a row on the tile. Also a drop of paratyphi A, B, C and typhus D of H antigen was placed on another row. Using the Pasteur pipette, a drop of serum was added to each reactant and mixed with a stirrer. One stirrer was used per sample to prevent contamination. The mixture was then gently rocked for two minutes and observed for agglutination.

Test result interpretation

Occurrence of agglutination was taken as an evidence for the presence *Salmonellae* species. The particular reagent on which the agglutination occurs showed the type of typhi present. The degree of agglutination was recorded in titres according to Cheesbrough (2006), thus:

Scanty agglutination	1: 40
Slight agglutination	1: 80
Heavy agglutination	1: 160
Very heavy agglutination	1: 320

Statistical Analysis

Data recorded from the study were analyzed statistically using GENSTAT. The chi square test at 5 % level of significance was used to determine significant differences in the prevalence of co-infection of malaria and typhoid fever with respect to village, age, sex, occupation and educational background.

Results

Of the 155 individuals examined for malaria and typhoid fevers in Ukpok community, 64 (41.71%) tested positive for malaria parasite (MP) infection; 60 (38%) tested positive for typhoid fever (TF) infection while 40 (25.0%) tested positive for both malaria and typhoid fever (Table 1).

Malaria prevalence in the villages ranged from 28.0 % in Umunuko village to 66.67 % in Ebe village. Typhoid fever prevalence ranged from 12.5 % in Umudike village to 68.0 % in Osigbu village. Malaria and typhoid fever co-infection in the villages was between 14.0 % in Umunuko village and 36.0 % in Umuohama village. This difference was statistically significant ($X^2 < 0.05$). No case of malaria and typhoid co-infection was observed in these villages.

Malaria prevalence was highest in the age group 0-10, 14 (73.68 %), and least in the age group 51 years and above, 13 (24.07 %). Typhoid fever prevalence was highest in the age group 51 years and above, 28 (51.85 %), and least in the age group 0-10 years, 2 (10.53 %). A significantly different typhoid fever and malaria co-infection was observed in all the age groups and its prevalence was between 10.5 % in the age group 0-10 years and 33.33 % in the age group 51 years and above ($\chi^2 < 0.05$) (table 2).

Infections with typhoid and malaria fevers were found in all the educational groups (table 3). The primary education group had the highest prevalence of malaria, 31 (60.7 %), while the secondary education group had the least prevalence, 12 (22.2 %). Typhoid fever prevalence was highest in non-formal education group 10 (57.1 %) and least in primary education group 14 (27.4 %). Co-infection of malaria and typhoid fevers was observed in all the educational groups with the highest prevalence among the tertiary education group,

9 (40.9 %), and the least among the secondary education group, 11 (20.3 %).

Of the 64 people positive for malaria, 40 (67.03 %) had mild infection (+), 16 (30.9 %) had moderate infection (++) while 3 (2.03 %) had heavy infection (+++). Both mild and moderate infections were observed in all the villages but heavy infection (+++) was observed in only two villages (Uboma and Agbuana) (table 4).

The prevalence of co-infection of malaria and typhoid fever in Ukpok community according to sex was 13 (30.9 %) for female participants, 27 (17.4 %) for the males (figure 1). The statistical analysis shows that there was no significant differences ($\chi^2 > 0.05$) between co-infection of malaria and typhoid fever between the sexes, eventhough more females than the males were infected with malaria, typhoid fever and their co-infection.

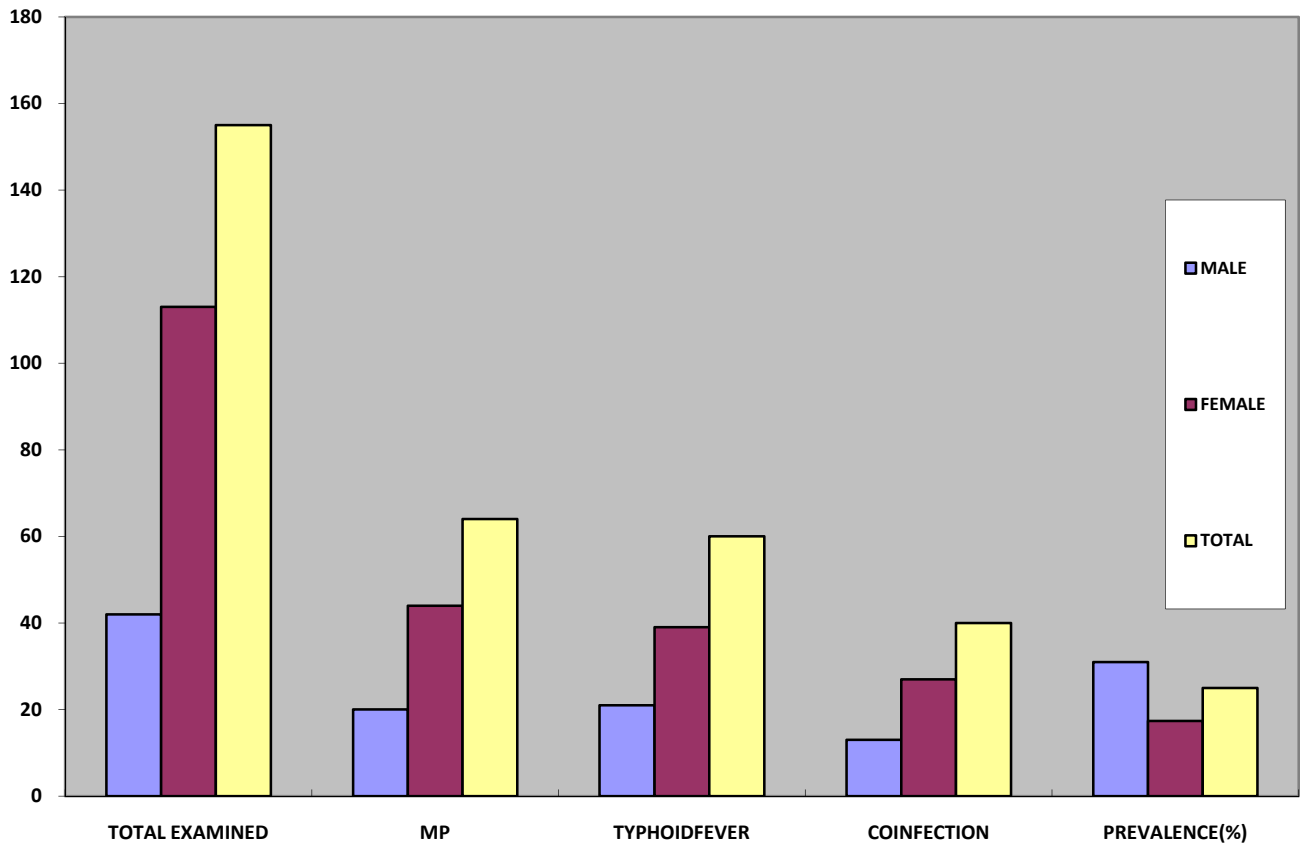


Figure 1: Prevalence of malaria and typhoid co-infection with respect to sex in Ukpok community, Anambra State, Nigeria

Figure 2 shows the co-infection of malaria and typhoid fevers in the occupational groups. The highest prevalence of co-infection was observed among the traders with prevalence of 37 % and the undergraduates

had the lowest prevalence of 10 %. Statistical analysis shows that there is significant differences in prevalence of co-infection of malaria and typhoid with occupation ($P < 0.05$).

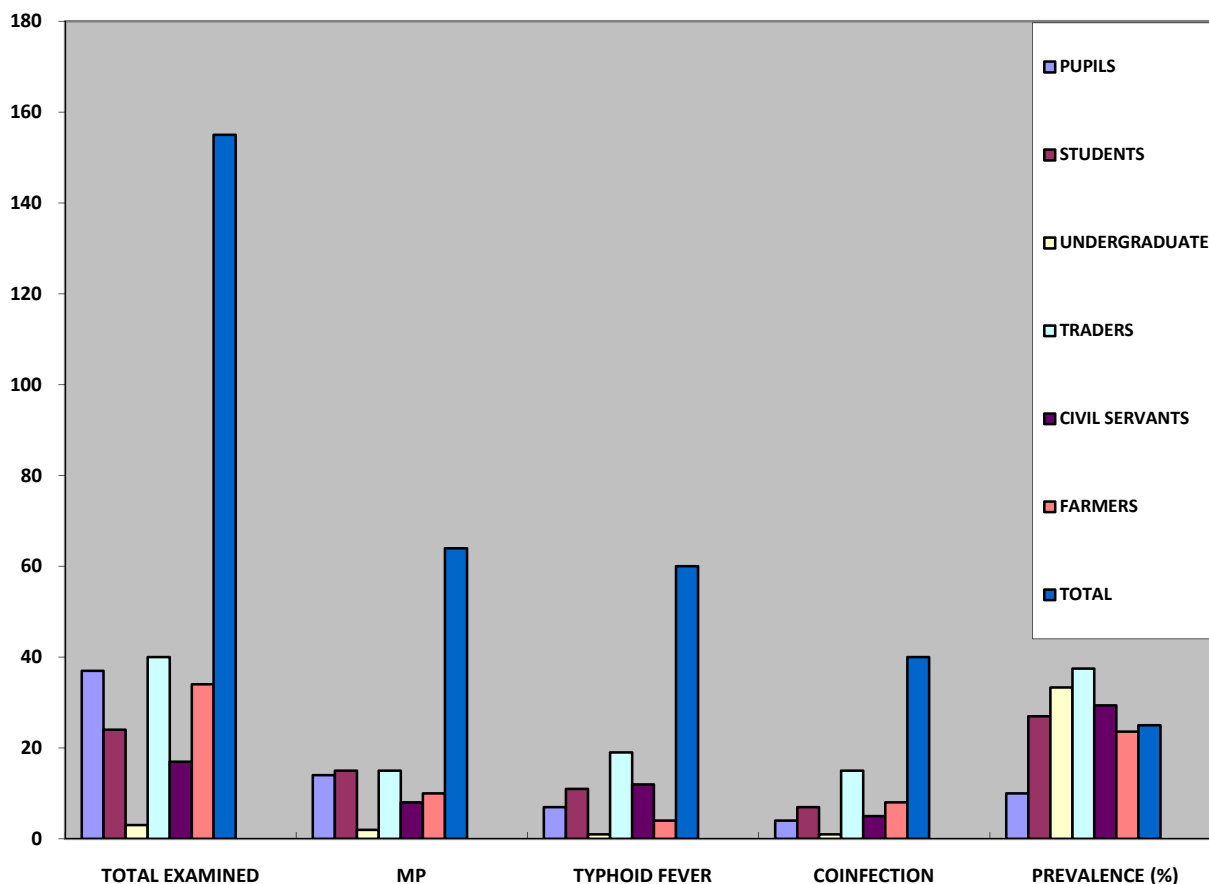


Figure 2: Prevalence of malaria and typhoid co-infection with respect to occupation in Ukpor community, Anambra State, Nigeria

Table 1: Prevalence of malaria and typhoid co-infection with respect to villages, in Ukpor community, Anambra State, Nigeria.

Villages	Number examined	Malaria Positives (%)	Typhoid Positives (%)	Co-infection	Prevalence (%)
Uboma	35	18 (51.0)	11 (31.4)	9	25.7
Agbuana	50	23 (46.0)	17 (34.0)	13	26.0
Umuohama	22	10 (45.0)	10 (45.4)	8	36.0
Umudike	8	4 (50.0)	1 (12.5)	0	0
Umunuko	7	2 (28.0)	2 (28.6)	1	14.0
Nzagha	5	3 (60.0)	1 (20.0)	1	20.0
Ebe	3	2 (66.67)	1 (33.3)	0	0
Osigbu	25	12 (48.0)	17 (68.0)	8	32.0
Total	155	64 (41.71)	60 (38.71)	40	25.81

Observed X^2 value = 96.9, df = 5; table X^2 value = 14.067, $P < 0.05$

Table 2: Prevalence of malaria and typhoid co-infection with respect to age, in Ukpok community, Anambra State, Nigeria.

Ages	Number examined	Malaria Positives (%)	Typhoid Positives (%)	Co-infection	Prevalence (%)
0-10	19	14 (73.68)	2 (10.53)	2	10.5
10-20	38	23 (60.53)	15 (39.47)	11	28.9
20-30	10	4 (40.00)	3 (30.00)	3	30.0
30-40	17	5 (29.41)	8 (47.06)	4	23.5
40-50	17	5 (29.47)	5 (29.41)	2	11.8
50-above	54	13 (24.07)	28 (51.85)	18	33.3
Total	155	64 (41.29)	60 (38.71)	40	25.81

Observed X^2 value = 31.62, df = 5; table X^2 value = 11.070.

Table 3: Prevalence of malaria and typhoid co-infection with respect to educational status in Ukpok community, Anambra State, Nigeria.

Educational status	Total examined	Malaria (%)	Typhoid (%)	Co-infection (%)
Primary	51	31 (60.7)	14 (27.4)	11 (21.5)
Secondary	54	12 (22.2)	18 (33.30)	11 (20.3)
Tertiary	22	11 (50.0)	12 (54.4)	9 (40.9)
Non-formal	28	10 (35.70)	16 (57.1)	9 (32.1)
Total	155	64 (41.29)	60 (38.7)	40 (25.8)

Table 4: Malaria intensity among participants in Ukpok community, Anambra State, Nigeria.

Villages	Number examined	Number of positives	+ (%) *	++ (%) **	+++ (%) ***
Uboma	35	16	9 (56.2)	6 (37.0)	1 (6.2)
Agbuana	50	20	15 (75.0)	3 (15.0)	2 (10.0)
Umuohama	22	5	4 (80.0)	1 (20.0)	0
Umudike	8	4	3 (75.0)	1 (25.0)	0
Umunuko	7	2	1 (50.0)	1 (50.0)	0
Nzagha	5	3	2 (66.7)	1 (33.0)	0
Ebe	3	2	1 (50.0)	1 (50.0)	0
Osigbu	25	12	19 (68.0)	2 (16.6)	0
Total	155	64	45 (67.03)	16 (30.9)	3 (2.03)

Keys: Light infection * (+) = 1-10 parasites per 100 high power fields Moderate infection ** (++) = 11-100 parasites per 100 high power fields Heavy infection *** (+++): 1-10 parasites per high power field

Discussion

Of the 155 apparently healthy individuals examined for typhoid and malaria fevers in Ukpok community, 64 (41.71 %) tested positive for malaria, 60 (38.0 %) tested positive for typhoid fever while 40 (25.0 %) were co-infected with malaria and typhoid fevers. This could be an indication that both typhoid and malaria are holoendemic in the area. Lucas and Gilles (2007) pointed out that in endemic populations, typhoid fever may occur as overt cases, ambulatory or missed cases or as symptomless carriers, while about 2-4 % of the typhoid patients become chronic carriers. Thomas *et al* (2004) opined that stable endemic malaria is a feature of holoendemic malaria population that

remains asymptomatic even in considerably high level of malaria intensity. It could be that asymptomatic malaria patients in the community were infected with typhoid fever or vice versa hence the participants were asymptomatic at the beginning of the study.

The overall prevalence of malaria in community was 64 (41.71 %). This result is by far higher than that of Anumudu *et al* (2006). Who reported 17.0 % prevalence among youths of eastern Nigeria, but lower than those of Aribodor *et al* (2003) and Onyido *et al* (2010) who reported malaria prevalence of 76.0 % and 62.0 % respectively at Azia and Umudioka communities, all in Anambra State of Nigeria. Malaria prevalence recorded in this study was also lower than

the prevalences of 58.2 % and 70.8 % respectively recorded by Onyido et al (2011a & b), at Ogbunike and Uli communities. The results compared favourably with prevalences of 46.0 % and 38.9 % observed at Nnewi and Awka by Umeanaeto et al (2006) and Onyido et al (2012). Epidemiology of malaria is however determined by many factors including parasite virulence, host immunity and environmental factors including geographical location (Eneanya, 1998). A tilt in any direction may favor or decrease malaria prevalence. Ukpok community is in the tropical rainforest and it is also traversed by many streams and rivers with extensive freshwater swamps and warm humid tropical climate that favour the breeding of vector mosquito species and rapid development of the parasites. The population of the community is also fairly large and encourages regular vector-man contact and malaria transmission.

Only 4.69 % of malaria-positive cases were heavy infections while mild and moderate infections were 70.31 % and 25.0 % respectively. This is a relatively small fraction of those infected with malaria (64). Rahim (2008) noted that innate immunity is an inherent property of the host that makes it susceptible to malaria infection or detrimental to the growth and proliferation of the parasite. It is possible that because of the constant exposure of the inhabitants to mosquito bites and malaria transmission, they appeared apparently healthy without obvious signs and symptoms of infections as a result of acquired immunity from repeated infections (Thomas et al 2004)

The overall prevalence of typhoid on Ukpok community was 60 (38.71 %). This result is higher than that of Onyido *et al* (2014) who observed a prevalence of 5.5 % at Ekwulumili community, in the same local government area. It is also higher than the prevalences of 20.0 % reported at Uyo by Obiekezie *et al* (2010). The prevalence of typhoid obtained in this study is relatively high. This difference could be due to differences in environmental sanitation behavior and personal hygiene of the residents of the two communities. Lucas and Gilles (2007) noted that typhoid fever has a worldwide distribution but endemic in communities where standard of sanitation and personal hygiene are low.

Typhoid fever was detected from all segments of the community including all the villages, gender, age groups, educational and occupational groups. This could be indicating that typhoid fever is endemic in the community. In Ukpok community, sewage disposal is indiscriminate around the surrounding fallow farmlands while some mischievous persons may even defaecate in fresh farms with vegetables and fruits thereby contaminating them. Flies or contaminated dust particles may contaminate human food with the infected faecal materials while flood may wash down

some to streams thereby contaminating their sources of water supply. Since typhoid is endemic in the community, it is likely that food and drinks may be directly contaminated by vendors who are carriers. This may be dangerous among people that depend on food vendors for most of their daily meals and drinks. Also cultural and traditional methods of greeting relatives and loved ones which involves warm embrace and handshaking may help also in the spread of the disease since close contact with a patient or carrier, whether family relation or otherwise may result in infection spread by soiled hands or even fomites such as towels and handkerchiefs (Lucas and Gilles, 2007).

Typhoid fever was highest in older age groups especially those aged 50 years and above and least in those less than 10 years of age. In addition to long periods of exposure leading to chronic carrier conditions, disease burden coupled with stress associated with old age could depress the community of these group to parasitic infections, hence higher prevalence in the older age groups. On the other hand, the younger generations get most of their daily meals and drinks from home where they might be properly cared for, and do not patronize the food vendors who may be chronic carriers as most of the adults do. This screens them from most infections hence low percentage of co-infection in the younger age groups.

The co-infection rate of malaria and typhoid fevers in Ukpok community was 40 (25.80 %). This observation agrees with the finding of Agwu et al (2009) who reported a co-infection rate of 20.9 % at Ekpoma, Edo State Nigeria. It is however far much higher than those of Onyido et al (2014) who observed a co-infection of 10 (5.5 %) in Ekwulumili community in the same local government area. The higher co-infection rate of malaria and typhoid fevers in Ukpok community could be due to the people's preference for stream and river water for drinking and domestic purposes than treated water in sachets and boreholes on the excuse that treated waters are not natural and do not have proper taste of water. The sanitation practices in Ukpok is poor and inadequate and could contaminate the water used by the people.

The highest co-infection rate of malaria and typhoid fever was observed among those aged 51 years and above. Uneke et al (2005) also observed a higher prevalence among the older age groups in a similar study in Jos, Plateau State, Nigeria. On the contrary, Onyido et al (2014) reported highest co-infection rate of 11.11 % among the age group 1-10 years and the least 2.78 % among those aged 61 years and above. The authors attributed the higher rate in the young people to lower levels of cell-mediated and humoral immunity. It is however expected that the older ones should be protected by acquired immunity developed over long years of exposure to the infection in their

lives. This could be so probably due to the people's preference for contaminated streams, rivers and stored rain waters from which they were constantly re-infected and became chronic carriers of the pathogens. Crump et al (2004) had earlier shown that exposure to polluted drinking water, proximity to human waste and refuse dumps, low standards of food preparation and ignorance contributed immensely to the occurrence, prevalence and transmission of typhoid. At old age, however, especially above 50 years, some organs of the body may be getting weak and as a result, the immune system may not perform maximally anymore to fight diseases. This may be part of the reason why there was a high prevalence among this age group. High prevalence of typhoid recorded among this age group could also be traced to their lesser attention to sanitation. They seem not to know the role of water supply and mosquito vectors on the transmission of malaria and typhoid fevers. Some of them claim that malaria and typhoid infections come as a result of eating fried food and taking a lot of fat and oil. The older people tend to stay outdoors to take air and engage in other activities such as farming and trading thus exposing themselves to mosquito bites. These are important predisposing factors.

Co-infection of malaria and typhoid fevers in the villages ranged from 14.0 % in Umunuko village to 36.0 % in Umuohama village. These could be attributed to poor sanitary conditions in the villages and their dependence on contaminated stream waters which is a constant source of infection. Also the dependence of most of the people on food vendors who might be ambulatory carriers could explain why most of the people were infected.

More males 13 (30.95 %) than the females 27 (17.4 %) were co-infected with typhoid and malaria though this was not statistically significant ($P > 0.005$). Onyido et al (2014) also observed higher co-infection in males than females. This could be attributed to the occupation of the people. Most men were traders rather than the traditional farmers and as such generally leave their homes very early in the morning and returning late in the day, depending only on food vendors for their meals and drinks. This exposes them to contaminated food and drinks from some chronic carrier food vendors, vis-à-vis higher infections.

The traders had the highest co-infection rate of 37.5 % while the applicants had the least 10.0 %, and the differences were statistically significant ($P < 0.05$). This shows that occupation may be associated with acquired malaria and typhoid fevers. Most traders are itinerant traders moving from one town to the other while others leave their homes early and return late in the evening. This makes them dependent on food vendors for their daily meals and drinks thereby exposing themselves to infections through

contaminated food from chronic carrier food vendors. Some equally rest and sleep in unprotected or even scantily dressed due to hot weather conditions, thereby exposing themselves to mosquito bites and malaria transmission.

Among the educational groups, malaria and typhoid fever co-infection was highest among the non-formal education group. This could be attributed to ignorance on the causes and transmission routes of malaria and typhoid fevers and their treatment seeking behaviours which is generally low. In addition some of them do not take treated water but show delight in stream and river waters which might have been contaminated with sewage.

Malaria and typhoid fevers are debilitating and life threatening disease associated with poverty and underdevelopment with significant morbidity and mortality (CDC, 2009; Irikannu and Onyido 2014). Both diseases are common in many countries of the world where the prevailing environmental conditions of warm humid climate, poor sanitary habits, poverty and ignorance exist. Intensified health education aimed at educating the populace on the dangers of such diseases, causes, prevention and treatment facilities available to them is advocated. Also source reduction of vector breeding sites, improved sanitary measures as well as mass screening and treatment of food vendors and other carriers should be instituted by the community, assisted by the government of the day.

Conclusion

The study has shown that the prevalence of malaria and typhoid fever infections in Ukpok community are high. The co-infection rate of these two ailments are equally high. This calls for the improvement of sanitary conditions to reduce breeding sites of mosquitoes and house flies that transmit these diseases. It also calls for proper personal hygiene and proper sewage disposal to reduce contamination of water and food with infected faecal matter. Intensified health education of the masses on how the diseases are acquired and their prevention should be prioritized.

Acknowledgement

The authors would like to thank the Department of Parasitology and Entomology, Nnamdi Azikiwe University Awka for making the laboratory available for this study. We are also grateful to all who contributed to the success of this work for their valuable comments and suggestions. We acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors/editors/publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

Corresponding author

Chikezie Friday Maduka
 Federal Ministry of Health, National Arboviruses and
 Vectors Research Center, Enugu, Nigeria
 Phone: +234 8037319887
 Email: meetfridayonline@yahoo.com

Authors' email addresses

Onyido Angus Ejidikeme: ae.onyido@unizik.edu.ng
 Okafor Afam Chibuikwe: okaforafamc@yahoo.com
 Chikezie Friday Maduka (Corresponding author):
meetfridayonline@yahoo.com
 Egbuche Chukwudi Michael:
chukwudiegbuiche@yahoo.com
 Umeanaeto Pauline Ukamaka:
mumamaka@yahoo.com
 Okafor Edwin: okaforen@yahoo.com
 Ezihe Ebuka Kingsley: eziheebuka@yahoo.com
 Iwueze Miriam Okwudili: mirobiukwu@yahoo.com
 Ogbonna Confidence Uchenna:
dollarsquare@gmail.com
 Anumba Joseph Uche: anumbajoe@gmail.com

References

1. Agwu C, Ihongbe JC, Okogun GRA and Inyang NJ. High incidence of co-infection with malaria and typhoid in febrile HIV infected and AIDS patients in Ekpoma, Edo State, Nigeria. *Brazilian J. Microbiol.* 2008; 40: 329-332.
2. Ammah A, Nkujo-Akenji T, Ndip R. & Deas JE. An update on concurrent malaria and typhoid fever in Cameroun. *Trans R soc Trop Med Hyg* 1999; 2: 127-9.
3. Anumudu CI, Adepoju A, Adeniran M, Adeoye O, Kassim A, Oyewole I. & Nwuba RI. Malaria prevalence and treatment seeking behavior of Nigerian youths. *Ann Afri Med.* 2006;15: 82-88.
4. Aribodir DN, Njoku OO, Eneanya CI, & Onyali IO. Studies on the prevalence of malaria and management practices of the Azia community in Ihiala L. G. A., Anambra State southeast Nigeria. *The Nigerian Journal of Parasitology* 2003; 24: 33-38.
5. CDC- Center for Disease Control and Prevention. National Typhoid and Paratyphoid fever Surveillance 2008; Retrieved from: http://www.cdc.gov/nationalsurveillance/typhoid_surveillance.html
6. CDC- Center for Disease Control and Prevention. Typhoid fever 2009; Retrieved from: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/typhoid_fever.html
7. Cheesbrough M. Examination of blood for malaria parasite. *District Laboratory Practice in Tropical Countries*. Part 1. Cambridge Low-Price Edition 2006; 239-258.
8. Crump JA, Luby SP, Mintz ED. The global burden of typhoid fever. *Bull World Health Org.* 2004; 82: 346-53.
9. Eneanya CI. Seasonal variation in malaria episodes among residents in a semi-urban community in South-East Nigeria. *The Nigerian Journal of Parasitology* 1998; 19: 39-43.
10. Irikannu CK & Onyido AE. *Trichomoniasis, Malaria and Typhoid fever: Case Studies in Africa*. Lambert Academic Publishing 2014; 7-50.
11. Lucas AO. & Gilles HM. Typhoid fever: In A short textbook of public health medicine for the tropics. Revised fourth edition (Book power) reprinted 2007, sponsored by Astrazeneca 2007; 59-61.
12. Obiekiezie SO, Asamudo NU and Akpan M. Concomitant bacteraemia and malaria parasitaemia among students of University of Uyo, South southern Nigeria. *J. Microbiol.* 2010; 24(1):2231-2234.
13. Oosterholt F, Martijnse G, Medema G. & Kooij Dick van der, Health risk assessment of non-potable domestic water supplies in the Netherlands. *J. of Water Supply: Research and Technology* 2007; —AQUA 56.3 101pp.
14. Onyido AE, Agbata VO, Umeanaeto PU, Obiukwo MO. & Amadi ES. Malaria burden and vector abundance in a sub-urban community in the rainforest zone of Nigeria. *Nigerian Journal of Microbiology* 2010; 24(1): 2224-2230.
15. Onyido AE, Obi NC, Umeanaeto PU, Obiukwo MO. & Egbuche MC. Malaria prevalence and indoor biting mosquito vector abundance in Ogbunike, Oyi L.G.A. Anambra State, Nigeria. *An International Multi Disciplinary Journal, Ethiopia* 2011a; 5(3): 1-13.
16. Onyido AE, Obinatu SC, Umeanaeto PU. & Obiukwo MO. Malaria prevalence and mosquito abundance in Uli town, Ihiala Local Government Area, Anambra State, Nigeria. *African J Biomed Research* 2011b; 14: 175-182.
17. Onyido AE, Ikpo AU, Obiukwo MO. & Amadi ES. Vector abundance and prevalence of malaria parasites among hostel residential students of Nnamdi Azikiwe University Awka, Southeastern Nigeria. *Nature and Science* 2012; 10 (11): 150-155.
18. Onyido AE, Ifeadi CP, Umeanaeto PU, Irikannu KC, Aribodor DN, Eneanya LC, Ugha CN and Obiechina IO. Co-infection of malaria and typhoid fever in Ekwulumili community, Anambra State, Southeastern Nigeria. *NY Sci. J.* 2014; 7(7): 18-27.

19. Rahim A. Human Salmonellosis: In Principles and Practice of Community Medicine. First Edition. JAYPEE Brothers Medical Publishers (P) Ltd, New Delhi, India 2008; 218-227.
20. Sachs J, Malaney P. The economic and social burden of malaria. *Nature* 2002; 415: 680-685
21. Smith DC. The rise and fall of typhomalarial fever. *J. Hist. Med. Allied Sci.* 1982; 37: 182-220.
22. Thomas CJ, Davies G. & Dunn CE. Mixed picture for changes in stable malaria distribution with future climate in Africa. *Trends Parasitol.* 2004; 20: 216-220.
23. Umeanaeto PU, Ekejindu IM. & Ifeanyichukwu MO. Prevalence and intensity of malaria in blood donors at Nnamdi Azikiwe University Teaching Hospital (NAUTH) Nnewi, Anambra State, Nigeria. *Nigerian Journal of Parasitology* 2006; 27: 11-15.
24. Uneke CJ, Ogbu O, Inyama PU. & Anyanwu GI. Malaria infection in HIV seropositive and HIV seronegative individuals in Jos, Nigeria. *J. Vect. Borne Dis.* 2005; 42: 151-154.
25. WHO., *Treatment of Typhoid Fever. Background Document: The Diagnosis, Prevention and Treatment of Typhoid Fever.* Communicable Disease Surveillance and Response to Vaccines and Biologicals: WHO 2003; Available at www.int/entity/vaccine_research/documents/typhoid_diagnosis.pdf.
26. WHO. *World Malaria Report.* WHO Press, Geneva, Switzerland. WHO/HTM /GMP/ 2008. 88pp.
27. WHO, *World malaria report.* Geneva, World Health Organization. http://www.who.int/malaria/publications/world_malaria_report_2012/en/index.html 2012; 69pp.

12/08/2015