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Prevalence of Malaria and Typhoid Co-infection amongst Residents of Uyo, Akwa Ibom State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors UOE, JAU, CAE and RUBE did the study design and wrote the protocol. Authors UOE and JAU did the statistical analysis and literature searches while analyses of study was by authors RUBE and CAE. All authors read and approved the final manuscript.

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ABSTRACT

Malaria and typhoid co-infection is of tremendous public health concern in Nigeria and the rest of sub-Saharan Africa. The prevalence of the co-infection was investigated in Uyo, the capital of Akwa Ibom State. A total of one hundred (100) blood samples were collected from patients with signs and symptoms of malaria and typhoid. These were then examined for malaria parasite using Giemsa stained thick blood films and typhoid fever using widal tube and agglutination tests. Positive widal samples with titre values greater ≥1:80 were regarded as significant and further subjected to blood culture. The socio-demographic factors examined revealed that about 43% were males and 57% were females. About 41% tested positive to malaria despite 85% admitting being on local and orthodox antimalarial therapies during presentation. A total of 64 (64%) gave significant titre (≥ 1/80) for *Salmonella*, however, only 11 (17%) of these gave positive blood cultures. Interestingly, those with positive blood cultures were also co-infected with malaria.

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1. INTRODUCTION

According to Centre for Disease Control (CDC) [1], Africa alone loses about $12 billion annually in direct and indirect expenses to malaria, making it the most clinically and economically important parasitic disease of man. Despite being successfully eradicated from the USA, Canada, Europe and Russia. Africa and some parts of Asia still bear the brunt of this infection. As expected, about 85% of cases and 90% of deaths occur in sub-Saharan Africa [2]. Malaria still claims the lives of about 2,000 people daily, majority of whom are children and pregnant women in Africa [2-4]. Vectored by the *Anopheles* mosquitoes, important clinical species include *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae and Plasmodium knowlesi* [2,5]. They differ in their symptoms, virulence, immunological and epidemiological characteristics, and sensitivity to drugs [5]. However, *P. falciparum* is the major human parasite responsible for high morbidity and mortality in Nigeria [4].

On the other hand, typhoid fever is a bacterial disease that is transmitted via the ingestion of foods, drinks and fruits contaminated with the faeces and urine of infected persons [6]. Like malaria, it is endemic in Africa. The *Salmonella* species that commonly causes typhoid fever in humans are *Salmonella paratyphi A, Salmonella paratyphi B, Salmonella paratyphi C and Salmonella typhi* [7,8]. The different serotypes of *Salmonella* can co-infect an individual or cause infections differently. Globally, typhoid is an important cause of morbidity and mortality in many regions of the world, with an estimated 12 - 33 million cases leading to 216,000-600,000 deaths annually [6,7,9].

Malaria and typhoid are a menace as far as sub-Saharan Africa is concerned. There seems to be a geographical overlap of both diseases as they are endemic in the same regions in Africa and Asia, and they are characterized by rapid population growth, increased urbanization, limited access to safe water, inadequate infrastructure and health systems [2,7]. Like malaria, typhoid is characterized by fever, weakness, anaemia, weight loss, vomiting and sometimes diarrhoea [7,10]. Once infection is triggered, humans depend on cell mediated immunity to clear both infections. A number of studies have shown that malaria could be co – infecting with typhoid [11,12]. Similar studies are currently lacking for most parts of the Nigeria including Uyo, the Akwa Ibom State capital hence the need to carry out this research.

2. MATERIALS AND METHODS

2.1 Study Site

This study was carried out at Majesty Hospital and Eye Clinic, Uyo, a major private hospital in Uyo, Akwa Ibom State, Nigeria. The state has a population of about 5 million, an area of 8,412 km^2 and is located in the Niger Delta region of the country. The state is bordered on the east by Cross River, on the west by Rivers and Abia States, and on the south by the Atlantic Ocean and the southernmost tip of Cross River State. Its mean annual temperature lies between 26℃ and 28℃, while mean annual rainfall ranges from 2,000 mm to 3,000 mm [13].

2.2 Sample Size and Collection

Simple random sampling method was used to obtain a sample size of one hundred (100) from the total number of persons that visited the study site between August 2014 and January 2015. About 5 ml of blood sample were collected from each participants as previously described by Niikura et al. [13].

2.3 Preparation of Thick and Thin Films and Microscopy

For each patient, both thick and thin blood films were prepared as described by and examined according to WHO [14].

2.4 Serum Preparation and Widal Test

Serum were prepared as previously described [15] for widal test and this was done using Cromatest Widal test reagents kits (Linear Chemical, Barcelona Spain). Each sample was examined using semi-quantitative and quantitative methods (slide and tube test, respectively). The slide test was performed by drawing six reaction circles on a title where one was regarded as positive and another as negative control, respectively. A drop of sera from each patient was then placed in the reaction circles. One drop of Widal test antigen H was then placed in the first two circles while to the other four remaining circles, a drop of O, H, AH and BH antigens were added respectively. These were properly mixed and then observed

macroscopically for agglutination within one minute. The presence of agglutination was regarded as positive. Positive samples were then subjected to standard tube agglutination test. Eight test tubes were labelled 1 to 8. To tube no 1, 1.9 ml of isotonic saline was added while the rest received 1ml of the same saline each. The first tube was made up to 2 ml by the addition of 0.1 ml of serum sample to give a 1: 20 dilution. The remaining tubes were serially diluted with 1ml of diluted serum from tube 2 to 3 and this was repeated till tube 7 but not to 8 resulting in the following dilutions (1:40, 1:80, 1:160, 1:320, 1:640 and 1:1280 for tubes 2 to 7). One drop each of the antigens were then added, mixed well, and incubated at 37℃ overnight. Reaction mixtures that gave visible agglutination with titre values of 1:80 and above were considered significant. The procedure was repeated for each of the positive samples.

2.5 Blood Culture of Positive Widal Samples

Blood samples that gave antibody titre ≥1/80 for *Salmonella* species were subjected to blood culture. Briefly, for each positive sample, exactly 1 ml of the positive blood samples from widal test were added to 9 ml of freshly prepared thioglycollate broth and incubated for about 48 hours at 37℃. Broths that tested positive were sub cultured onto MacConkey agar. Cultural characteristics and routine biochemical tests were used to identify the isolates [15].

2.6 Design and Administration of Questionnaires

A total of a hundred (100) questionnaires were designed using open ended questions to provide information about the socio-demographic factors of participants and predisposing factors to both infections. Informed consents were obtained from all participants before inclusion.

2.7 Data Analysis

Data were analysed using basic descriptive statistics such as percentages, and Chi square and Spearman correlation test for significance at 95% probability level using Statistical Package for Social Science (SPSS) Version 21.

3. RESULTS

A total of 43 males and 57 females took part in this study with ages ranging from 10 to 80 years. Majority of the participants were 10 to 40 years age bracket and over half (51%) were single. Sixty four (64%) tested positive to typhoid and this was not surprising as about 70% and 80% respectively, were in the habit of drinking untreated water and washing their hands less than three times a day. However, only 11 (17%) of those that tested positive to widal gave positive blood results. Interestingly, 56% were very knowledgeable about the aetiological agents of malaria and typhoid (Tables 2 and 3). Those that tested positive to malaria were 41 while 49 were negative (Table 3). A total of 64% tested positive to widal of which only 11(17%) were positive with blood culture. The prevalence of both co-infection with malaria stood at 16 % (n =100) and 17% (n=64) for widal and blood culture, respectively (Table 5).

4. DISCUSSION

A number of studies have shown that malaria could be co-infecting with HIV and typhoid. Co-co-infection with HIV has been blamed on geographical overlap and possibility of immunological and therapeutic interactions [16,17]. Therefore, it seems only reasonable to extend such argument to explain the co-infections between malaria and typhoid fever as both are endemic, elicit cell mediated immunity and also almost always treated together when symptoms are seen. In the last two decades, the possibility of a relationship between malaria and *Salmonellae* has been confirmed by studies from Africa that largely describe a higher incidence of non-typhoidal salmonella bacteremia among patients with malarial observations [18,19]. Despite eighty five (85%), admitting to being on orthodox or locally prepared antimalarial therapies, a total of 41% still tested positive to malaria. This was lower than the 74.60% and 72% previously reported by Ohalete et al. [16] and Adefioye et al. [3], respectively.

Our findings indicate that the prevalence of malaria and typhoid co-infection though not significant stood at 16% (n = 100) and 17% (n = 64) for widal and blood culture respectively. Correlation analysis gave strong correlation of 0.97 and 0.60 respectively for widal and blood culture. This is close to Igharo et al. [20] who reported a prevalence of 18.3% and Opara et al. [21] that also reported a non-significant co-infection prevalence of 22% in Imo State. In another study in Pakistan, it was found that subjects with co-infection were found to have significantly higher rates of nausea, vomiting, abdominal pain, and diarrhea, all common presenting features of enteric fever [22].

Table 1. Socio-demographic factors of the participants

Parameters	Male (%)	Female (%)	Total (%)
Sex	43	57	100
Age range			
10-20	20	30	50
21-40	16	25	41
41-60	3	5	8
61-80	0	1	1
Marital status			
Single	28	31	59
Married	10	16	26
Widow	-	10	10
Widower	5	-	5
Occupation			
Students	20	28	48
Civil servants	19	17	36
Others	4	12	16
Religion			
Christianity	40	55	95
Islam	3	2	5
Education level			
Secondary	8	7	15
Lower diploma	6	4	10
Higher diploma	14	8	22
Bachelor degree	15	10	25
Master degree	4	1	5
Non-formal education	14	9	23

Table 2. Risk factors predisposing participants to malaria and typhoid

Risk factors	No (%)	Yes (%)	Total (%)
Malaria			
Use of insecticide treated bednets/Screened rooms.	55	45	100
Knowledge about etiologic agents of malaria	44	56	100
Antimalarial therapy	15	85	100
Typhoid			
Knowledge about etiologic agents of typhoid	44	56	100
Drinking of untreated or unboiled water	**30**	70	100
Frequent washing of hands (3 times daily and above)	80	20	100

Table 3. Prevalence of malaria according to age range

Age range	Yes (%)	No (%)
10-20	22	28
21-40	14	27
41-60	4	4
61-80	1	0
Total	**41**	**59**

Analysis showed a significant correlation (0.95) at 0.05 probability level (p= 0.12)

Table 4. Prevalence of typhoid according to age range

Age	Widal test (n = 100)	Blood culture (n = 64)
10-20	22	3
21-40	34	5
41-60	7	3
61-80	1	1
Total	**64 (%)**	**11 (17%)**

Analysis showed no significant correlation (0.90) at 0.05 probability level (p =0.07)

Table 5. Prevalence of co-infection according to age range

Parameters	Positive widal (n =100)	Positive blood (n= 64)	Positive malaria (%) n= 100
Age range			
10-20	8	3	22
21-40	7	5	14
41-60	1	3	4
61-80	0	1	1
Total	**16**	**11**	**41**

Analysis gave a strong correlations of 0.97 and 0.60 respectively for widal and blood culture, respectively

5. CONCLUSION

The findings in this study confirm the fact that malaria and typhoid are indeed halo-endemic in Uyo and there is indeed a co-infection though not significant statistically. Thus, there is a need to conduct further studies that will elucidate the exact nature of this co-infection.

ETHICAL APPROVAL

Ethical approval was obtained from the management of Majesty Hospital and Eye Clinic in Uyo Akwa Ibom State and fully complied with. Data protection act was completely followed in handling the data obtained from the participants following their informed consent.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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