Keywords
Malaria, Typhoid Fever, Co-infection, Haematological Parameters, Patients, Wukari

Prevalence of Malaria and Typhoid Fever Co-infection and the Haematological Profile of Patients Attending Hospitals in Wukari Taraba State, Nigeria

Ubandoma Andefiki*, Awache Ibrahim, Ebuara Francis Ushie
Department of Microbiology, Faculty of Pure and Applied Sciences, Federal University Wukari, Wukari, Nigeria

Email address
andefiki.ubandoma@fuwukari.edu.ng (U. Andefiki), andefiki13@gmail.com (U. Andefiki)
*Corresponding author

Citation

Abstract
This study on the prevalence of malaria and typhoid fever co-infection and the haematological profile of patients attending hospitals in Wukari Taraba State was concluded in June, 2017. The aim was to determine the prevalence of malaria and typhoid fever co-infection and their effects on blood parameters. It goes without saying, that both malaria and typhoid fever are endemic in the tropical regions in which Nigeria is no exception. Veinous blood was used for the various analyses. Of the 100 patients examined, 88(88%) patients were positive for malaria and 64(64%) patients were positive for typhoid fever. Females were more infected with both malaria and typhoid fever (91% and 64.2% respectively) than males (84% and 63.6% respectively). However, the difference in the prevalence of infections between the genders were statistically insignificant (P >0.05). In the prevalence of co-infection, 56(56%) patients were co-infected. Of the 56 patients, 23(52.3%) were males and 33(58.9%) were females. Gender and age wise, males between age group 31 – 40 years had the highest co-infection (75%) while females between age group 41 – 50 years had the highest prevalence of co-morbidity. In the haematological analyses, this study showed that a reasonable percentage of malaria and typhoid fever infected patients were anaemic (25%), 5.4% had higher than normal leucocyte count, 21.4% with lymphocyte count lower than normal and 8.9% of the co-infected patients had monocyte count higher than the normal range.

1. Introduction
Malaria and Typhoid infections have been associated with increasing poverty, deterioration in sanitation, poor public health services, compounded by increasing drug resistance of the two etiologic agents [1]. Owing to this high poverty rate, a large number of Wukari residents live in houses where there are no clean, safe drinking water and poor or no drainage system. Also, because both malaria and typhoid fever share similar predisposing factors (such as poverty, poor sanitation and public health services etc), and present in the same way, individuals in areas endemic for these infections are being put at a substantial risk of contracting both concurrently.

The concurrent occurrence of both malaria and typhoid fever (malaria – typhoid
Typhoid fever (co-infection) was first described in the Medical Literature in the middle of the 19th century and was named typhoid-malarial fever by the United State Army Doctor Joseph J. Woodward (1833 – 1884) in 1862. Typhoid – malaria fever was found among young soldiers during the American Civil War who were suffering from febrile illness that seemed to be typhoid rather than a new species of disease [2].

Malaria originates from Medieval Italian: *mala aria* meaning "bad air"; the disease was formerly called *ague or marsh fever* due to its association with swamps and marshland [3]. The term first appeared in the English literature about 1829 [4]. It is a mosquito-borne infectious disease that affects man and other animals and is caused by parasitic protozoans belonging to the *Plasmodium* species [5]. In humans, malaria is caused by *P. falciparum, P. malariae, P. ovale, P. vivax* and *P. knowlesi* [6]. *P. falciparum* traditionally accounts for the majority of deaths [7], recent evidence suggests that *P. vivax* malaria is associated with potentially life-threatening conditions about as often as with a diagnosis of *P. falciparum* infection [8].

Malaria infection develops via two phases: one that involves the liver (exoerythrocytic phase), and one that involves red blood cells, or erythrocytes (erythrocytic phase). When an infected mosquito pierces a person's skin to take a blood meal, sporozoites in the mosquito's saliva enter the bloodstream and migrate to the liver where they infect hepatocytes, multiplying asexually and asymmetrically for a period of 8–30 days [9]. Mosquito parasite is therefore relatively protected from attack by the body's immune system because for most of its human life cycle it resides within the liver and blood cells and is relatively invisible to immune surveillance.

The World Health Organization (WHO) estimates that in 2015 there were 214 million new cases of malaria resulting in 438,000 deaths [5]. Others have estimated the number of cases at between 350 and 550 million for falciparum malaria [10]. According to Layne (2007), malaria is presently endemic in a broad band around the equator, in areas of the Americas, many parts of Asia, and much of Africa; in Sub-Saharan Africa, 85–90% of malaria fatalities occur. An estimate for 2009 reported that countries with the highest death rate per 100,000 of population were Ivory Coast (86.15), Angola (56.93) and Burkina Faso (50.66) [11].

Typhoid fever is caused by the gram negative bacterium *Salmonella typhi*, also known as *Salmonella enterica* serotype Typhi [12]. There are two main types of Typhii namely the ST1 and ST2 based on MLST subtyping scheme, which are currently widespread globally [13].

The bacterium that causes typhoid fever may be spread through poor hygiene habits and public sanitation conditions, and sometimes also by flying insects feeding on feces. Public education campaigns encouraging people to wash their hands after defecating and before handling food are an important component in controlling spread of the disease. Sanitation and hygiene are important to prevent typhoid. Typhoid does not affect animals other than humans. Typhoid can only spread in environments where human feces or urine are able to come into contact with food or drinking water. Careful food preparation and washing of hands are crucial to prevent typhoid.

Changes in haematological parameters are likely to be influenced by any disease condition including endemic diseases, such as malaria and typhoid fever, which can affect human health with various clinical presentations. Haematological changes are some of the most common complications in these infections and they play a major role in their pathogenesis. These changes involve the major cell types such as red blood cells, leucocytes and thrombocytes.

The similarities in the predisposing factors to both malaria and typhoid fever infections and the similar signs and symptoms presented by both infections have propelled researchers into investigating the co-infection of these diseases. Apparently, this present study may be useful to individuals, medical practitioners, government policy makers and researchers. The findings from this research hopefully will form the basis for further research while providing baseline epidemiologic data for further studies.

2. Materials and Method

2.1. Study Area

The study was carried out in Wukari Local Government Area of Taraba State. Wukari Local Government Area is in the Southern Senatorial District of Taraba State. Its headquarter is in the town of Wukari on the A4 highway. The Donga River flows through the area and the Benue River forms a boundary with Nasarawa State to the northwest. The town is the base of the Wukari Federation, a traditional state. It has an area of 4,308 km² and a population of 241,546 at the 2006 census.

The occupation of the inhabitants of the area is basically farming. Although some are civil servants while others are involved in one form of trade or the other.

2.2. Study Population

A total number of one hundred (100) patients (age ranged 1 to 70 years) consisting of 75 patients from General Hospital and 25 patients from Bethel Hospital both in Wukari town, out of which 44 males and 56 females attending these hospitals were included in the study. These patients were selected for the study as there were considered to be in a better position to give accurate and reliable information required for the study regarding the co-infection of malaria and typhoid within the metropolis. The researcher was indifferent as to whether the patients were nationals or nonnationals or has varying social classes or religion.

2.3. Sample Collection

Five milliliters (5ml) of blood sample was collected by venepuncture from each patient into ethylenediaminetetraacetic acid (EDTA) tubes by trained and
licensed medical laboratory technologists from the two hospitals.

2.4. Examination for Malaria Parasite

Thick blood films were made by using the end of a pipette to apply a large drop of blood on the slide to produce a thick smear. An area of about 15 mm × 15 mm was covered by the film.

The blood films were air-dried and the slide placed on a horizontal position. Field stains A and B were used for staining. The slides were placed face downwards on a slide rack. Immersion oil was added by the edge and it spread to cover an area of about that is equivalent to the diameter of the film. Blood films were examined under ×100 objective and malaria parasites recorded. The trophozoites, schizonts and gametocytes were looked for. A smear was considered negative for malaria parasites if no parasites were seen after examining at least 100 microscopic fields [14].

2.5. Widal Test

This is a serological technique used to detect the presence of *Salmonella* antibodies in the patient’s serum. Serum was obtained from 5ml of the patient’s venous blood. Quality control was done to ascertain the effectiveness of the Widal kits.

The agglutination test was performed on all blood samples by the rapid slide titration method using CJ Smart Widal commercial antigen suspensions, for the somatic (O) and flagella (H) antigens by adding one drop of the widal antigen suspension to the reaction circles containing the patient’s serum. The content of each circle was uniformly mixed over the entire circle with separate mixing sticks. The slides were gently rocked back and forth, and observed for agglutination for one minute. A positive widal test was considered for any serum sample with antibody titre ≥ 1:160 to the O and H antigens of *S. typhi*.

2.6. Identification

Positive samples were identified on the basis of microscopy for malaria parasite and agglutination reaction for widal test. The following plus sign scheme was used to report parasite numbers [14]:

- 1 – 10 parasites per 100 high power fields +
- 11 – 100 parasites per 100 high power fields ++
- 1 – 10 parasites in every high power field +++
- More than 10 parasites in every high power field ++++

The degree of agglutination in widal test was recorded in titres according to manufacturer’s instruction of CJ Smart antigen suspension reagents as follows:

- No agglutination 1:20
- Scanty agglutination 1:40
- Slight agglutination 1:80
- Heavy agglutination 1:160
- Very heavy agglutination 1:320

2.6.1. Estimation of Packed Cell Volume (PCV) and Haemoglobin (Hb)

The aim of the PCV test was to measure the volume of packed red cells present in the blood. The principle of the PCV test is the ability of different blood components (red and white blood cells, and platelets) to pack together according to their rate of sedimentation after centrifuging for 5 minutes using the Haematocrit centrifuge. Similarly, Haemoglobin was also estimated by Sahli’s haemoglobinometer (acid haematin method).

2.6.2. Total White Blood Cell (WBC) Count

The total WBC count was determined by measuring 0.38ml of Turk’s solution using 1ml pipette into a clean cuvette in which 0.02ml (20µL) of blood sample was measured using a micropipette and also added, mixed and incubated for 1 hour. WBC count was read microscopically by counting each of the cells as seen on the Hemocytometer (Neubaer’s counting chamber).

2.6.3. WBC Differential Count

The identification of the different types of white blood cells was done. In identifying the numbers of different WBC, a thin blood film was made, stained with Leishman’s stain, observed microscopically using the X100 objective and a large number of WBC (at least 100) was counted. This gave the percentage of cells that are of each type. By multiplying the percentage by the total number of WBC, the absolute number of each type of WBC was obtained. Five (5) kinds of WBC were encountered viz; neutrophils, lymphocytes, monocytes, eosinophils, and basophils.

3. Result

**Table 1.** Overall prevalence of Malaria using Field stains A and B, and Typhoid fever using CJ Smart Widal reagent.

<table>
<thead>
<tr>
<th>Illness</th>
<th>No. Examined</th>
<th>No. Infected</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>100</td>
<td>88</td>
<td>88.0</td>
</tr>
<tr>
<td>Typhoid</td>
<td>100</td>
<td>64</td>
<td>64.0</td>
</tr>
</tbody>
</table>

In table 1 above, the overall prevalence of malaria and typhoid fever shows that 88(88%) and 64(64%) patients were respectively infected.

**Table 2.** Malaria prevalence between genders of patients.

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. Tested</th>
<th>No. Infected with Malaria (observed frequency)</th>
<th>Expected Frequency</th>
<th>Percentage positive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>44</td>
<td>37</td>
<td>44</td>
<td>84.0</td>
</tr>
<tr>
<td>Females</td>
<td>56</td>
<td>51</td>
<td>44</td>
<td>91.0</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>88</td>
<td>88</td>
<td>88</td>
</tr>
</tbody>
</table>
The distribution of malaria (Table 2 above) showed that of the 44 males examined, 37(84%) were positive and 51(91%) of the 56 females were positive for malaria.

**Table 3. Typhoid fever prevalence between genders of patients.**

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. Tested</th>
<th>No. Infected with Typhoid fever (observed frequency)</th>
<th>Expected Frequency</th>
<th>Percentage positive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>44</td>
<td>28</td>
<td>32</td>
<td>63.6</td>
</tr>
<tr>
<td>Females</td>
<td>56</td>
<td>36</td>
<td>32</td>
<td>64.2</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>64</td>
<td>64</td>
<td>64.0</td>
</tr>
</tbody>
</table>

In table 3 above, 28(63.6%) males out of the 44 tested were positive for typhoid fever while 36(64.2%) female patients were typhoid positive.

In Figure 1 above, the prevalence of malaria and typhoid fever among patients across different age groups is shown. Most patients were in the age group of 21 – 30 years (38 patients) and the least were in the age group of 61 – 70 years with 2 patients. The age groups of 41 – 50 years and 51 – 60 years had the highest malaria prevalence rate of 11(100%) and 5(100%) respectively, while the age group of 61 – 70 years had the lowest malaria prevalence rate of 1(50%). Also, age group of 51 – 60 years had the highest typhoid fever prevalence rate of 4(80%) while age group 61 – 70 years had the least typhoid fever prevalence rate of 1(50%).

**Table 4. Frequency and Distribution of co-infection with malaria and typhoid fever between genders of patients.**

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. Tested</th>
<th>No. infected with both Malaria and Typhoid fever</th>
<th>Percentage positive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>44</td>
<td>23</td>
<td>52.3</td>
</tr>
<tr>
<td>Females</td>
<td>56</td>
<td>33</td>
<td>58.9</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>56</td>
<td>56.0</td>
</tr>
</tbody>
</table>

According to table 4 above, of the 100 patients tested for malaria and typhoid fever co-infection, 56(56%) patients were concurrently infected with both malaria and typhoid. In terms of gender distribution, 23(52.3%) of the 44 males were co-infected while 33(58.9%) of the 56 female patients were co-infected with malaria and typhoid fever.
The occurrence of co-infection among the different age groups with respect to their gender (Figure 2 above) showed that among the 23(52.3%) males co-infected, age group 31 – 40 years had the highest prevalence rate of co-infection of 6(75%) while age group 51 – 60 years had no co-infection. Out of the 33(58.9%) females co-infected with malaria and typhoid fever, age group 41 – 50 years had the highest prevalence rate of co-infection of 5(83.3%) while age group 61 – 70 years had no co-infection. Overall, age groups 31 – 40 years and 41 – 50 years (i.e. 31 – 50 years) were shown to be the most co-infected and age groups 51 – 60 years and 61 – 70 years (i.e. 51 – 70 years) were the least infected with both malaria and typhoid fever.

Table 5 above shows the haematological parameters among malaria infected patients. and none of the patients had PCV above normal. 2(2.3%) patients had abnormally low leucocyte count (lower than 3,500µL), 82(93.2%) patients had normal leucocyte count (between 3,500µL and 10,500µL) while 4(4.5%) patients had leucocyte count higher than normal (above 10,500µL). 1(1.1%) patient had neutrophil count lower than the normal range (less than 45%), 83(94.3%) patients had normal neutrophil count (between 45% and 75%) and 4(4.5%) showed neutrophil count above normal (greater than 75%). 17(19.3%) of the malaria positive patients had lymphocyte count below the normal range of between 20 – 40%, 70(87.5%) had normal lymphocyte while 1(1.1%) patient had lymphocyte count above normal. For monocyte count, 77(92.0%) patients had normal count (between 1% and 10%) while 11(12.5%) patients had monocyte count higher than normal. No patient showed monocyte count below the normal range. Eosinophil count was normal (count less than 7%) for 81(92.0%) patients and above normal for 7(8.0%) patients. Lastly, 85(96.6%) patients had normal basophil count (less than 3%) and 3(3.4%) patients had basophil count above normal.

Table 6. Haematological parameters among typhoid fever infected patients.
In table 6 above, the haematological parameters among typhoid fever positive patients show that 14(21.9%) of the 64 infected patients had PCV/Hb lower than normal, 50(78.1%) positive patients had normal PCVs and none of the patients had PCV above the normal range. 2(3.1%) patients had abnormally low leucocyte count, 59(92.2%) patients had normal leucocyte count while 3(4.7%) patients had leucocyte count higher than normal. 1(1.6%) patient had neutrophil count lower than normal, 61(95.3%) patients had normal neutrophil count and 2(3.1%) showed neutrophil count above normal. 12(18.8%) of the typhoid positive patients had lymphocyte count below the normal range, 50(78.1%) had normal lymphocyte while 2(3.1%) patients had lymphocyte count above normal. For monocyte count, 58(90.6%) patients had normal count while 6(9.4%) patients had monocyte count higher than normal. No patient showed monocyte count below the normal range. Eosinophil count was normal for 60(93.6%) patients and above normal for 4(6.3%) patients. All typhoid positive patients had normal basophil count.

Figure 3 shows the haematological parameters among malaria and typhoid fever co-infected patients. From the figure, 14(25.0%) of the 56 co-infected patients had PCV/Hb lower than normal, 42(75.0%) co-infected patients had normal PCVs and none had PCV/Hb above the normal range. 2(3.6%) patients infected with both malaria and typhoid fever had abnormally low leucocyte count, 51(90.0%) patients had normal leucocyte count while 3(5.4%) patients had leucocyte count higher than normal. 1(1.8%) co-infected patient had neutrophil count lower than normal, 53(94.6%) patients had normal neutrophil count and 2(3.6%) had neutrophil count above normal. 12(21.4%) of the co-infected patients had lymphocyte count below the normal range, 43(76.8%) had normal lymphocyte while 1(1.8%) patient had lymphocyte count above normal. For monocyte count, 52(92.9%) patients had normal count while 5(8.9%) patients had monocyte count higher than normal. No patient showed monocyte count below the normal range. Eosinophil count was normal for 52(92.9%) patients and above normal for 4(7.1%) co-infected patients. All the patients concurrently infected with both malaria and typhoid fever had normal basophil count.

4. Discussion

Of the 100 patients attending selected hospitals in Wukari in which 75 patients from General Hospital and 25 from Bethel Hospital were included in the study, 56(56%) were females and 44(44%) males. Included patients were between the ages of 1 and 70 years with most of the patients being youths (between the age of 18 and 35years).

This study shows that the overall prevalence (88%) of malaria in Wukari is high. The prevalence rate (64%) of typhoid fever as well as the co-morbidity (56%) of malaria and typhoid fever is also very high. The overall prevalence of malaria 88(88%) and typhoid 64(64%) were similar to the figure obtained in Calabar (80.8% and 46.8% respectively) by Orok et al in 2016 [15]. Malaria prevalence rate in this study was also similar to the value reported in Sierra Leone (79.94%) but typhoid prevalence rate 64(64%) in this study was relatively lower than the figure (83.5%) reported in the
The prevalence rate of malaria was higher in females 51(91%) than males 37(84%), however, no significant association existed statistically (P > 0.05). This occurrence contrasts the result obtained in Calabar by Orok et al which showed that males (85.8%) are more infected than females (76.6%). This may not be unconnected with the fact that females seem to sweat more than males especially in a high temperature locality like Wukari and may often not like the idea of sleeping under insecticide treated nets.

Typhoid fever prevalence rate was also slightly greater in females 36(64.2%) than in males 28(63.6%), but was not statistically significant (P > 0.05). This prevalence rate corresponds to that reported in Samaru by Mbah and Agu [17] in which females had slightly higher prevalence rate of typhoid fever (45.3%) than males (42.2%). This higher frequency of typhoid fever in females may be due to the fact that they are regularly engaged in household activities like cooking and washing with unsafe water. Considering the different age groups tested, it was seen that the age group of 41 – 50 years and 51 – 60 years with malaria prevalence rate of 11(100%) and 5(100%) respectively basically contrasts with the popular view that age groups 0 – 10 years and 11 – 20 years are most infected. However, it is worthy of acceptance that they are more susceptible to the disease in areas of high transmission. Naturally acquired immunity builds up in older adults following repeated exposure to malaria parasite and this might have accounted for the least prevalence rate of 1(50%) of patients between 61 – 70 years of age.

Age group 51 – 60 years had the highest typhoid fever prevalence rate of 4(80%) which corresponds to the report of Okore et al for residents of Obuda- Aba, Abia State which showed that age group of 46 – 60 years has the highest prevalence rate (48.33%) of typhoid fever. However, the least typhoid prevalence rate of 5(50%) in age group 61 – 70 years as shown in this study contrasts the figure obtained by Orok et al in which age group 46 – 60 years (40.7%) had the least prevalence rate. The higher prevalence rate in age group 51 – 60 years may be due to the fact that most people within this age group in Wukari are working class and usually choose to feed during working hours in restaurants proximal to their working places and it’s possible proper hygiene might not have been maintained or the food might not have been well prepared.

The prevalence of malaria and typhoid co-infection (56%) in this study is higher than that reported by Mbah and Agu in Samaru in which the prevalence rate of co-infection was 15.2%. The rate of co-infection in this study was also higher than the value reported in Calabar by Orok et al in which the prevalence rate of malaria and typhoid fever co-morbidity was 28%. The rate of co-infection in this research was also higher in females (58.9%) than in males (52.3%). This is somewhat not strange because females are more exposed to mosquitoes and spend time in farms and markets where they do their petty trades and therefore lack access to potable water. In terms of age group cum gender, males in the age group of 31 – 40 years had the highest co-infection rate of 6(75%) while age group 51 – 60 years had no co-infection (0%). This does not agree with the report of most other researchers especially that of Orok et al in which the highest co-infection rate (37.5%) was in the age group of 1 – 15 years. In females, the age group 41 – 50 years had the highest co-infection rate (83.3%) of malaria and typhoid fever while age group 61 – 70 years had no co-infection. This was similar to the report of Mbah and Agu in Samaru in which co-infection rate in female adults was 75%.

Overall, the very high prevalence rate of malaria in Wukari as seen in this research may be as a result of consistent high temperature along with stagnant waters in which mosquito larvae readily mature, providing them with the environment they need for continuous breeding. Similarly, the high prevalence rate of typhoid fever could be as a result of lack of access to clean water, proper sanitation systems, and proper health care facilities.

This study showed obvious changes in the haematological parameters of patients infected with malaria. 20(22.7%) had haemoglobin lower than the threshold 11mg/dL haemoglobin level for children, a figure considerably lower than the 87.5% reported by Shah et al at Ahmedabad in India [18]. However, there was no significant difference between low haemoglobin in malaria-positive patients and that in malaria negative patients (P > 0.05). Changes noticed in other haematological parameters such as neutrophil and eosinophil count above normal level for children, a figure considerably lower than the 87.5% were similar to the report of Mbah and Agu in Samaru in which the highest
c

10(25%) of typhoid fever positive patients had lower PCV/Hb, a figure lower than that reported by Shilpa et al (34.48%) in Kalagurbi, India [19] but there was also no significant difference between low haemoglobin in typhoid-positive patients and that in typhoid-negative patients (P > 0.05). Leucocyte count was fairly normal in most of the patients positive for typhoid fever (92.2%), although showed higher counts compared to negative patients. Neutrophil count in typhoid positive patients was mostly normal (95.3%) i.e in 61 of the 64 positive patients which agrees with the statement of Hoffbrand et al 1996, that neutrophil count can only be abnormally elevated in complicated typhoid fever.

In this study, 14(21.9%) of typhoid fever positive patients had lower PCV/Hb, a figure lower than that reported by Shilpa et al (34.48%) in Kalagurbi, India [19] but there was also no significant difference between low haemoglobin in typhoid-positive patients and that in typhoid-negative patients (P > 0.05). Leucocyte count was fairly normal in most of the patients positive for typhoid fever (92.2%), although showed higher counts compared to negative patients. Neutrophil count in typhoid positive patients was mostly normal (95.3%) i.e in 61 of the 64 positive patients which agrees with the statement of Hoffbrand et al 1996, that neutrophil count can only be abnormally elevated in complicated typhoid fever.
infected patients was higher than normal in 3(5.4%) patients. This could be due to the body’s effort to resist infection by plasmodium and salmonella resulting in continuous production of leucocytes.

5. Conclusion

There is a high prevalence of malaria and typhoid fever infections and co-infections in Wukari that require adequate attention to reduce morbidity. Infections with malaria and typhoid fever have noticeable effects on blood parameters, although minute, could serve as useful indices during diagnosis. Both malaria and typhoid fever remain life-threatening and a major health problem in under developed and developing countries like Nigeria and since both infections cut across all strata of the society, irrespective of age and sex as shown in this study, all hands must be on deck in order to turn the tide around in favour of millions who are affected or are at risk.

Finally, it is important to note that though typhoid and malaria have effects on blood components, it will be slightly out of place to attribute the changes in the haematological profile of patients to malaria and typhoid fever alone.

References


