Research Article

Prevalence of Malaria and Typhoid Fever in Different Age Groups, visiting Government, Private and Tertiary Care Hospitals of Lahore

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Abstract | Malaria and typhoid fever are the infections of main public health significance and are among the most endemic diseases in tropical and developing countries. The similarity in the symptoms of both infections leads to misdiagnosis which further leads to mistreatment. Present study was undertaken to investigate the prevalence of malaria and typhoid fever by visiting private hospital, government hospital, and tertiary care hospitals of Lahore. For this purpose, 800 blood and serum samples of the suspected patients were collected from September to mid of March. Thick and thin blood smear methods were used for diagnosis of malaria whereas the Widal agglutination technique was employed for diagnosis of typhoid. Results revealed that out of 800 suspected cases, 14.50% were found to be positive for malaria and typhoid with no case of co-infection. Out of positive cases, 57.75% were positive for typhoid and 42.24% were positive for malaria. It was found that most malarial cases were in September and more typhoid cases were in October and March. Furthermore, it was observed that malaria was high in males and among the aged up to 15 years (61.44%), mostly in rural areas (75.51%) and typhoid was high in females and among the age of up to 15 years (65.67%), mostly in rural areas (55.22%). *S. typhi* was dominant with 82.08% cases and *P. vivax* was dominant with 75.51% cases. This study revealed the high prevalence of malaria and typhoid fever. Hence, more attention should be given to these fevers.

Received | January 15, 2022; **Accepted** | April 30, 2022; **Published** | June, 2022
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Email: asma5latif@hotmail.com
Citation | Latif, A.A., Awan, A., Khan, A., Ali, K.S. and Farooq, A. 2022. Prevalence of Malaria and Typhoid Fever in Different Age Groups, visiting Government, Private and Tertiary Care Hospitals of Lahore. *Journal of Innovative Biology and Environmental Sciences*, *2*(1): 31-40
Keywords | Malaria, Typhoid, Misdiagnosis, Serum, Widal test, Blood smears

1. Introduction

Malaria and typhoid fever persist as infections of main public health significance within the tropics (UNEKE, 2008). Both diseases are common in various countries where poverty, warm tropical temperatures, poor hygienic practices, and ignorance are present. Recent studies have identified these two infections to be concomitant with poverty and underdevelopment (Uzoka *et al.*,

2021; Qureshi *et al*., 2019).According to the World Health Organization (WHO), about 11 to 20 million cases of typhoid fever occur annually, which results in 128,000 to 161,000 deaths per year. Malaria affects about 1 billion people each year, out of which approximately one to three million succumb to it (Chilongola *et al*., 2018).

The term Malaria derives from ancient Italian; mal and aria meaning "bad air". Due to its connection with swamps and marshland, this disease was primarily called marsh fever (Reither, 1999). It is caused by five species of *Plasmodium* that is transmitted through the bite of an infected female *Anopheles* mosquito (Iwuafor *et al*., 2016; Mbah *et al*., 2015; Ukaegbu *et al*., 2014).

The two most prevalent species of *Plasmodium* in Pakistan are identified as *P. vivax* and *P. falciparum* (WHO, 2012). Malaria is mostly found in the provinces of Sindh, Baluchistan, and KPK (Kakar *et al*., 2010). Both children and adults are susceptible to malaria, but children under the age of 5 years are the most affected demographic (Hussain *et al*., 2013). Malaria, in combination with other diseases, kills a child every 30 seconds. The acute malaria disease may kill a child within 24 hours (Nizamani *et al*., 2006).

During malaria, infection becomes more severe due to hematological and biochemical changes (Kremsner *et al*., 2016). In malaria patients, white blood cell (WBC) count stays constant while lactate dehydrogenase increases. The fever rises quickly up to 38.9°C to 41°C during malaria. Fever and chills are followed by diaphoresis and physical discomfort (Woodruff and Wright, 2013). Other symptoms include vomiting, headache, and diarrhea. Acute intravascular hemolysis is characterised by the passage of dark red or black-colored urine, which is a rare and fatal complication of malaria caused by *P. falciparum* (Edet *et al*., 2016).

Antimalarial medical intervention is based on the severity of symptoms, parasite species and the likelihood of potential drug resistance. Infections caused by *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi* acquired in chloroquine-susceptible areas may be treated with chloroquine, otherwise, treatment with an ACT is recommended. Patients with severe malaria require intensive care and parenteral treatment with intravenous antimalarial treatment (Kafai *et al*., 2018).

The word typhoid has originated from the Greek word 'Typhos' meaning smoke or fumes. Typhoid is a multi-systemic bacterial illness caused by *Salmonella* species, subspecies enteric, and serovar *typhi* (Devaranavadagi *et al*., 2017). Typhoid fever is prevalent in the subcontinent, Middle East, Southeast Asia, and South and Central America, with high cases reported in Pakistan. The main threat in Pakistan, especially in Karachi, is poor hygiene values, unclean water supply, and underlying socio-economic conditions. The main reservoirs for *S. typhi* are contaminated water and food and patients get infected by typhoid fever via ingestion (Essa *et al*., 2019). Typhoid is mainly a disease of school-age children and young adults (Devaranavadagi *et al*., 2017).

The incubation period of typhoid is of usually 1-2 weeks. Typhoid symptoms appear as sustained fever, abdominal pain, fatigue, dry cough, constipation, and diarrhea (Hameed *et al*., 2018). Typhoid carriers shed the bacteria in stool and urine. Ingestion of contaminated food or water with *S. typhi* from human stools is the most common mode of transmission of typhoid (Prajapati *et al*., 2008). From 1-3 weeks of point of ingestion, *S. typhi* spends anywhere within the intestine before making its way through the intestinal wall and eventually into the

bloodstream of the host (Mayo, 2016). Bacterium rapidly replicates into macrophages. Some re-enter the bloodstream, while others enter the GI (Gastrointestinal) tract and shed in feces. Without proper treatment, the infection can lead to kidney failure, intestinal bleeding, and perforation leading to death (CDC, 2016).

Widal tests or blood cultures are more commonly used for the diagnosis of typhoid fever (Parry *et al*., 2011). Wrong diagnosis and treatment of a patient having a fever occur due to similarities in the clinical features of malaria and typhoid fever (Hassan *et al*., 2011).

Current study was carried out to investigate analyse and correlate the age, gender, area, month and species-wise prevalence of malaria and typhoid fever by visiting Government hospitals, Private hospitals, and Tertiary care hospitals of Lahore.

2. Materials and Methods

2.1. Study Area

Lahore District is located in the Pakistani province of Punjab, mainly consisting of the city of Lahore. The total population of Lahore is 6,310,888. Lahore features five seasons. It was selected based on climatic conditions suitable for mosquito breeding, contaminated water, and poor sanitation suitable for typhoid fever.

2.2. Duration of Study

The duration of the study was from September 2019 to Mid-March 2020.

2.3. Study Population

Present study was conducted on blood and serum samples of patients with typhoid and malarial symptoms visiting Government Hospital (Services Institute of Medical Sciences), Tertiary Care Hospitals (Sir Ganga Ram Hospital and Mayo Hospital), and Private Hospital (Ittefaq hospital) of Lahore.

2.4. Inclusion Criteria

Patients with typhoid and malarial signs and symptoms such as fever, abdominal pain, diarrhea, and vomiting were included in this study.

2.5. Collection of Samples

Eight hundred (800) blood and serum samples of patients were collected with the help of the hospital's laboratory staff. The blood and serum intended for parasitological and bacterial examination were collected from patients with typhoid and malarial symptoms. Laboratory and research work were performed in the Parasitology lab of the Zoology Department, Lahore College for Women University, Lahore (LCWU). For malaria, blood samples were collected from the finger via prick by the middle and ring finger of the patients as usage of capillary blood to diagnose malaria is more sensitive than venous blood (Njunda *et al*., 2013). To obtain serum for typhoid diagnosis, blood samples were allowed to clot and then centrifuged to remove the clot and blood cells. PCD (Passive Case Detection) technique was applied in which blood films were taken from health stations and carried to the laboratory where these slides were stained with the help of Giemsa's stain (Manson-Bahr, 1946).

2.6. Data Collection

Data collection was based on gender, age, and residential area. For this purpose, samples were collected from suspected subjects of malaria and typhoid from both males and females of different ages from September 2019 to Mid-March 2020. Questionnaires were filled to obtain information on the patient's age, gender, and residential area.

2.7. Diagnostic Techniques

Serum samples of all patients for typhoid were examined by Widal test which is an agglutination test which detects the presence of serum agglutinins (H or O) in

patient's serum (Urban, 2004). For diagnosis of malaria, blood samples of all patients were examined by making thick and thin blood smears.

2.8. Interpretation of Data

Data were entered and analysed and presented in graphical form on Excel version 2016. Categorical variables were compared with the Chi-square test. A *p*-value of <0.05 was considered statistically significant. Prevalence was found by the following formula:

$$\text{Prevalence (\%)} = \frac{\text{No. of positive cases}}{\text{Total No. of cases}} \times 100$$

3. Results

3.1. Overall Prevalence

Out of 800, a total of 116 (14.50%) infected cases were found positive and, about 684 (85.5%) cases were found to be negative for malaria and typhoid in private and government hospitals of Lahore (table 1 and figure 1). There was no significant difference between positive and negative cases (p= 0.08).

Table 1: Overall prevalence

Total samples tested	No. of infected samples	Prevalence (%)
800	116	14.50%

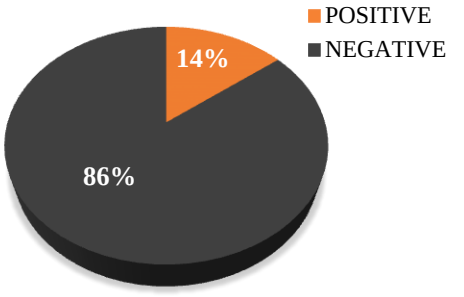

Figure 1: Graph showing the overall percentage of positive and negative cases

3.2. Prevalence of Malaria and Typhoid

In 116 total infected cases, 49 patients were found positive for malaria which was about 42.24% of the total cases and 67 cases were found positive for typhoid, which was about 57.75% of the total infected cases (table 2 and figure 2). There were no cases of co-infection of either malaria or typhoid. Hence, infection of typhoid was more prevalent than malaria. There was a significant difference between the prevalence of malaria and typhoid (p= 0.01).

Table 2: Prevalence of malaria and typhoid and co. infection

Illness	Infected patients (total 116)	Prevalence (%)
Malaria	49	42.24%
Typhoid	67	57.75%
Co. infection	0	0%

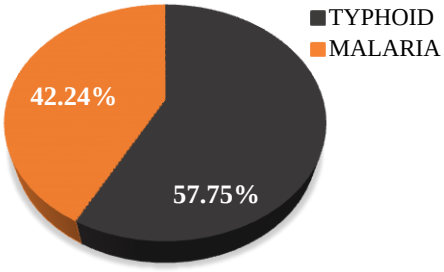

Figure 2: Graph showing the prevalence of malaria and typhoid

3.3. Species of Salmonella

We examined species of *Salmonella* in patients affected with typhoid. Among 67 typhoid-infected patients, 55 (82.08%) patients were infected with *Salmonella typhi* and 12 (17.91%) patients were infected with *Salmonella paratyphi* (table 3 and figure3).

Table 3: Specie wise prevalence of *Salmonella* species

Illness	*S. typhi*	Prevalence (%)	*S. paratyphi*	Prevalence (%)
Typhoid	55	82.08%	12	17.91%

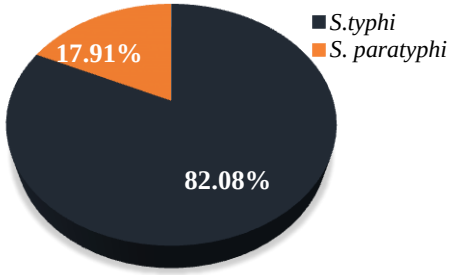

Figure 3: Graph showing the prevalence of *Salmonella* species

3.4. Species of Plasmodium

We examined species of *Plasmodium* in patients affected with malaria. Among

those 37 (75.51%) patients were affected with *P. vivax*, 12 (24.48%) patients were affected with *P. falciparum* and there was no case of mixed infection of *P. vivax* and *P. falciparum* (table 4 and figure4). There was no case of any other species of Plasmodium. Hence, the majority of the patients were infected with *P. vivax*.

Table 4: Specie wise prevalence of *Plasmodium* species

Illness	*P. vivax*	Prevalence (%)	*P. falciparum*	Prevalence (%)
Malaria	37	75.51%	12	24.48%

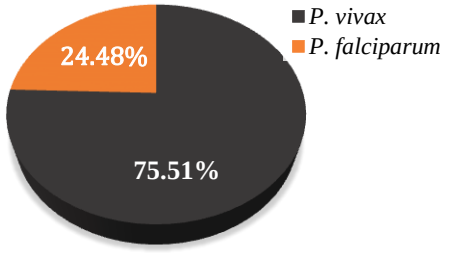

Figure 4: Graph showing the prevalence of *Plasmodium* species

3.5. Area Wise Prevalence

For area-wise prevalence, we divided the area into two types; one was urban and the other was rural. Among the total of 49 malarial cases, 12 (24.48%) patients were from urban areas and 37 (75.51%) patients were from rural areas. Among the total of 67 typhoid-infected cases, 30 (44.77%) patients were from urban areas and 37 (55.22%) patients were from rural areas.

Table 5: Area wise prevalence of malaria and typhoid

Factor	Urban	Prevalence (%)	Rural	Prevalence (%)
Malaria	12	24.48%	37	75.51%
Typhoid	30	44.77%	37	55.22%

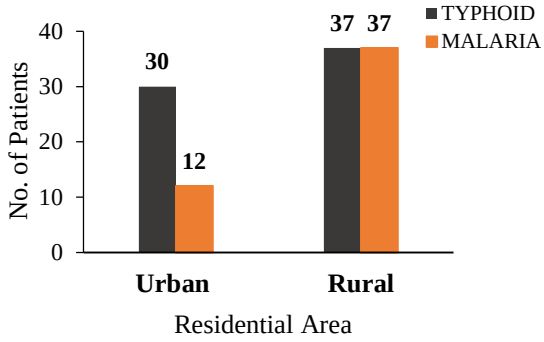

Figure 5: Graph showing the area-wise prevalence of typhoid and malaria

Hence, malaria and typhoid were more common in rural areas than urban areas (table 5 and figure 5). There was no case of co-infection of malaria and typhoid. There was a significant difference between the area-wise prevalence (p=0.02).

3.6. Gender Wise Prevalence

In the total of 49 malarial cases, 36 (73.46%) cases were positive for males and 13 (26.53%) cases were positive for females. In the total 67 typhoid cases, 27 (40.29%) cases were positive for males while 40 (59.70%) cases were positive for females (table 6 and figure 6). Hence, malaria was more common in males than females and typhoid were more common in females than in males. There was no case of co-infection of typhoid and malaria. There was a significant difference between the gender-wise prevalence (p=0.0003).

Table 6: Gender wise prevalence of malaria and typhoid

Factor	Total infected samples	Males	Prevalence (%)	Females	Prevalence (%)
Malaria	49	36	73.46%	13	26.53%
Typhoid	67	27	40.29%	40	59.70%

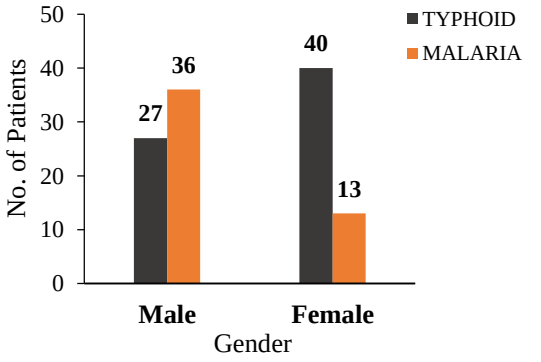

Figure 6: Graph showing the gender-wise prevalence of typhoid and malaria

3.7. Age Wise Prevalence

For the age-wise prevalence, we have taken four age groups (up to 15 years, 16 to 30 years, 31 to 45 years and, more than 45 years). In the total 49 malarial infected cases, patients of age up to 15 years were 30 (61.44%), patients of age from 16 to 30 years were 10 (20.40%), patients from age 31 to 45 years were 6 (12.24%) and

patients of age more than 45 years were 3 (6.12%). The total typhoid cases were 67 among which patients of age up to 15 years were 44 (65.67%), patients of age from 16 to 30 years were 13 (19.40%), patients of age from 31 to 45 years were 6 (8.95%) and patients of the age more than 45 years were 4 (5.97%) (table 7 and figure 7). Hence, typhoid infection was more common in the age group of up to 15 years than the any other age group and malaria was more common in the patients of age up to 45 years than the patients of age more than 45 years. There was no significant difference between the age-wise prevalence of malaria and typhoid (p=0.9).

Table 7: Age wise prevalence of malaria and typhoid

Age	Malaria	Prevalence (%)	Typhoid	Prevalence (%)
Upto 15 yrs	30	61.44%	44	65.67%
16-30 yrs	10	20.40%	13	19.40%
31-45 yrs	6	12.24%	6	8.95%
Above 45 yrs	3	6.12%	4	5.97%

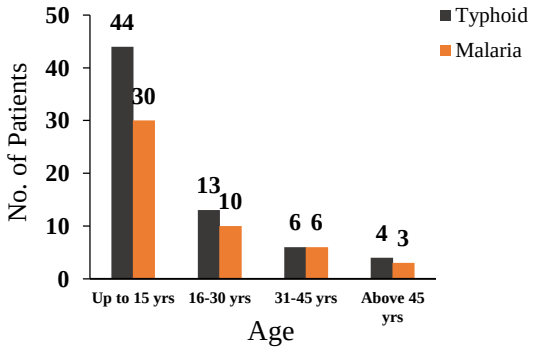

Figure 7: Graph showing the age-wise prevalence of typhoid and malaria

3.8. Month Wise Prevalence

In September, the total infected cases were 11, of which malarial cases were 5 (45.45%) and typhoid cases were 6 (54.55%). In October, the total infected cases were 7 of which 2 (28.57%) cases were positive for malaria and 5 (71.42%) cases were positive for typhoid. In November, the total infected cases were 15 of which 6 (40%) cases were positive for malaria and 9 (60%) cases were positive for typhoid. In December, the total cases were 20 of which 6 (12%) cases were positive for malaria and 14 (70%) cases were positive for typhoid. In January, the total infected cases were 20 of which there were 6 (12%) cases of malaria and 14 (70%) cases were positive for typhoid. In February, the total infected cases were 25 of which there were 11 (44%) cases positive for malaria and 14 (56%) cases were positive for typhoid. In March, the total infected cases were 5 and all cases were positive for typhoid (table 8 and figure 8). Hence, malaria was more common in September and typhoid was high in March but remained high in all months. There was no significant difference between the month-wise prevalence of malaria and typhoid (p=0.13).

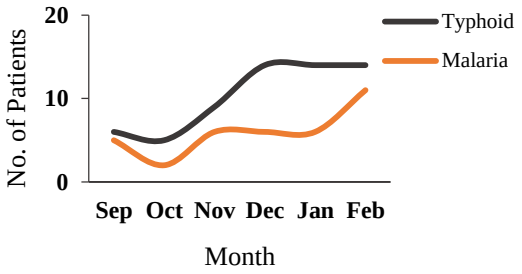

Figure 8: Graph showing the monthly trend of malaria and typhoid

4. Discussion

Malaria is a serious illness caused by *Plasmodium*. *Plasmodium* enters the human body through the mosquito bite while typhoid is a bacterial infection caused by *Salmonella typhi* and *paratyphi* which is often passed through the contaminated food and drinking water.

The present study was conducted to find out the prevalence of malaria and typhoid fevers by visiting the private hospital, government hospital and, tertiary care hospitals of Lahore. Our results showed that 116 out of 800 patients were positive for both malaria and typhoid infection which showed 14.50% of the overall prevalence of both malaria and typhoid. Among these, typhoid infected about 67

Table 8: Month wise prevalence of malaria and typhoid fevers

Month	Total infected samples	Malaria	Prevalence (%)	Typhoid	Prevalence (%)
September	11	5	45.45%	6	54.54%
October	7	2	28.57%	5	71.42%
November	15	6	40%	9	60%
December	20	6	12%	14	70%
January	20	6	12%	14	70%
February	25	11	44%	14	56%
March	5	0	0%	5	100%

out of 116 patients which showed about 57.75% prevalence of typhoid while malaria-infected 49 patients out of 116 total infected patients which showed 42.24% prevalence of malaria. These results showed that typhoid was more prevalent than malaria. This is in agreement with the findings of Qureshi *et al*. (2019) who reported 58% prevalence of typhoid and 38% prevalence of malaria which showed a high prevalence of typhoid than malaria which is similar to our findings but we did not find any case of co-infection of malaria and typhoid that was contrary to their findings. This difference may be due to the area and seasonal differences because this study was done from September to mid of March and only the summer season understudy was suitable for mosquito breeding.

Gender wise prevalence results showed that about 73.46% cases of malaria were found in males and about 23.53% cases were found in females which showed that malaria was higher in males than females which is similar to the findings of Khan *et al*. (2019) who reported that males were more infected with malaria than females. We found that about 40.29% of cases of typhoid were in males and about 59.70% cases of typhoid were found in females which showed that typhoid was more found in the females than in males, which is similar to the findings of Rasul *et al*. (2017) who reported that typhoid seemed higher in females 52.62% as compared to males 47.38%.

Our area wise prevalence results showed that about 24.48% of cases of malaria were from urban areas and 75.51% cases were from rural areas which showed that the prevalence of malaria was more in rural areas than in urban areas which are similar to the findings of Sultana *et al*. (2017) who reported that the prevalence of malaria was higher among patients which belonged to rural areas as compared to urban areas. It was observed that about 44.77% cases of typhoid were in urban patients and about 55.22% cases of typhoid were in rural patients which showed the prevalence of typhoid was more in patients who belonged to rural areas as compared to the urban areas which were similar to the findings of Tareen (2014) which reported that typhoid was more common in the patients who belonged to rural areas than urban areas.

Our results showed that 61.44% of malaria was more prevalent in patients of age up to 15 years as compared to other age groups which are similar to the findings of Khan *et al*. (2019) which reported a high prevalence of malaria among patients of age <16 years. We found a high rate of typhoid infection among patients of age up to 15 years which was about 65.67% which is similar to the findings of Jalani *et al*. (2019).

Zeeshan *et al*. (2018) accomplished a survey and determined a higher rate of *P. vivax* infection than *P. falciparum* infection in patients infected with malaria

which is similar to our findings in which we found a high rate of *P. vivax* infection which is about 82.08% as compared to *P. falciparum* which is about 17.91%.

5. Conclusion

The prevalence of typhoid was very high as compared to malaria. So, education on the prevention of typhoid is greatly needed. Since both diseases have similar symptoms, therefore proper diagnostic procedures are required to prevent misdiagnosis. Further prevalence based studies and investigations should be made on a seasonal basis concerning abiotic factors to develop control strategies against these infections in the study area.

6. Acknowledgments

We thank the Department of Zoology, Lahore College for Women University, Lahore and Services Institute of Medical Sciences, Lahore for chemicals and laboratory usage.

7. Author's Contribution

Asma Abdul Latif planned and designed the study. Ansa Awan, Ayesha Khan and Kiran Sardar Ali collected the samples, data. They also contributed in data analysis and article write up. Asma Abdul Latif and Azhar Farooq overlooked the project and manuscript preparation.

8. Conflict of Interest

No conflict.

9. Novelty Statement

Pakistan is a developing country, and like other developing nations of Asian region, Pakistan is also endemic to malaria and typhoid fevers. Malaria typhoid co-infection are a relevant concern and need to be addressed for its prevention and control. Prevalence data on these fevers results in emergence of a dire image, where simple preventive measures such as hygiene management can stave off medical interventions and mortalities.

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