Research Article

Prevalence and distribution of human malarial infection in district Multan, Punjab, Pakistan

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Citation

Muhammad Zafar, Iram Mushtaq, Samrah Masud, Muhammad Zahid Khan, Muhammad Khalil Ahmad Khan and Asmatullah. Prevalence and distribution of human malarial infection in district Multan, Punjab, Pakistan. Pure and Applied Biology. Vol. 8, Issue 1, pp873-881. <http://dx.doi.org/10.19045/bspab.2019.80029>

Received: 16/11/2018

Revised: 21/02/2019

Accepted: 06/03/2019

Online First: 14/03/2019

Abstract

The present study was undertaken during 2015-17 with the objective to provide data of malarial infections in human population based on incidences in twenty different localities of district Multan, Punjab, Pakistan. The blood slides of suspected patients were studied to identify the malarial parasites. Slide positivity was found to be 1478 (39.20%) out of 3770 and *Plasmodium vivax* infection was 905 (61.23%), *Plasmodium falciparum* 425 (28.75%) and mixed species (*P. vivax* and *P. falciparum*) 148 (10.01%) were identified. In the month of December, 150 cases (73.25%) of *P. vivax* infection counted to be the highest, whereas, 42 cases (58.33%) of *P. vivax* in the month of September were recorded. The *P. falciparum* infection remained highest in the month of August with 58 cases (25.66%) and lowest in the month of May with 24 (23.76%). Similarly infection of mixed species remained highest 30 (13.27%) in August and lowest 7 (7.60%) in the month of February. Infection in male was highest 850 (57.51%) and female was lowest 628 (42.48%). No incidence of *Plasmodium ovale* and *Plasmodium malariae* infection was to be observed in this study. The results of present research work concluded that *P. vivax* and *P. falciparum* are serious health hazards which can ultimately lead to serious cerebral malaria problems. However, no association was found between age group, sex and type of infection. Therefore, it can be concluded that the incidence of any type of infection may happened from person to person of any age group and in any sex.

Keywords: Incidence; Infection; Multan; Mixed species; *Plasmodium falciparum*; *Plasmodium vivax*

Introduction

Malaria is known as a major parasitic diseases in all over the world. Over 225 million malarial cases were reported in 2011. Species *Plasmodium falciparum* is the most severe form of malaria parasite. Mostly it is transmitted through the bite of an infected

female mosquito known as *Anopheles* when it feeds on human beings [1].

Malaria is known as one of the most devastating disease throughout in the world and 4 billion people live under the threat of malaria in 25 endemic countries [2] and each

year it kills over a million mostly children [3].

Malaria is considered as one of the major poverty disease and needs to be eradicated. Due to consequences of malaria, children below five years and pregnant women are felt hardest. With the lack of hygiene and proper nutrition, a child dies from malaria after every thirty seconds [4].

At CMH, Multan [5] 125 cases of *Plasmodium falciparum* malaria were studied to evaluate seasonal variations and modes of transmission. The incidence of *Plasmodium falciparum* remained high among troops during the months of August to November. In general population of district Buner, [6] studied prevalence of malaria and recorded highest rate of infection (11.71%) in the month of August while in March the lowest rate of infection (3.8%) was noted. In pediatric age group 250 cases of malaria were investigated by [7] who found high rate of infection of *Plasmodium vivax* (63.2%) as compared to infection of *Plasmodium falciparum* (35%). In Karachi including other areas of province Sindh, Malaria was studied by [8] it was observed that infection of *Plasmodium vivax* were more than two times higher than the infection of *Plasmodium falciparum*. In many districts of the province Sindh [9] found that *Plasmodium falciparum* ratio was increasing day by day. In North West Frontier Province (NWFP) malaria was studied by [10] who observed cerebral malaria as more common infection in males and for pregnant females it was highly vulnerable. In another study [7] among the 165 cases of malarial parasite in children, 145 cases were diagnosed as *Plasmodium vivax* and 20 cases of *Plasmodium falciparum*. At Ayub Teaching Hospital Abbottabad the study regarding the pattern of malarial infection by [11] 1998 patients were screened and 150 (7.5%) were found to be infected by *Plasmodium vivax* in 72.2% and *Plasmodium falciparum* in 24.3% cases.

In Balochistan, cerebral malaria is declared as a major community problem. In a study [12] to observed epidemiology of cerebral malaria and its mortality in patients in Quetta City, 63% cases of cerebral malaria in children while 37% cases in adults were investigated. Furthermore, in a study of urban and rural areas of Quetta district [13, 14] in 2003 and 2004 in the age group of 22 and above, higher rate of incidence of *Plasmodium falciparum* (17.8%, 16.4%, respectively) were noted. A recent report about malaria from Pakistan, which was published in 2017, evidence sustained decrease in the number of cases, but however we are unable to achieve the target in all over the world about malarial eradication [15].

Many studies have been conducted to investigate the knowledge, attitudes and practices of people with respect to malaria but only few to know the cause of malaria. Investigating the rate of prevalence of malarial parasites in human population of the Multan district was the objective of present study.

Materials and methods

Multan is located in the southern part of the province Punjab, Pakistan. Multan is known as an arid area with very hot summer and cold winters. In winter the average lowest temperature is 4.4°C (40.1°F) while in summer the highest average temperature recorded is 42.2°C (108.1°F).

Different localities of Multan district were studied during August 2015 to July 2017 and blood of human patients suffering from malaria was screened to record malarial parasite species. The patients were categorized into 5 different age groups: 1-10 years of age, 11-20 years, 21-30 years, 31-40 years and 41 years and above. Two different methods were adopted to detect malarial cases. [16] A) PCD (Passive Case Detection) technique where blood films were taken from health stations from the patients with symptoms leading to malaria. B) ACD

(Active Case Detection) where blood films are prepared and collected from the persons with symptoms and signs of malaria during home visits. The blood slides collected using the PCD and ACD [16] techniques were carried to laboratory where these slides were stained with the help of Giemsa's stain. From the keys furnished by [17] identification of species of parasites was made.

Results

A total 3770 blood smears were prepared from 5 age groups ranging from 1 year to 41 years and above from different localities of Multan District of Southern Punjab during

August 2015 to July 2017. However, due to different localities with different hygienic conditions variations were observed throughout the district Multan.

Out of 3770 cases studied, 1478 cases were found to be of *Plasmodium* positive counting to 39.02% of total population studied. Regarding species, *Plasmodium vivax* was observed to be the highest 905 (61.23%) as compared to that of *Plasmodium falciparum* 425 (28.75%) and mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) 148 (10.01%) (Table 1 & 2).

Table 1. Area-wise prevalence of Malaria infection in Southern Punjab (District Multan)

Sr. No.	Area Name	No. of Slides Examined	Total No. of Positivity	<i>Plasmodium vivax</i> No. and %	<i>Plasmodium falciparum</i> No. and %	Mixed species (<i>P. vivax</i> and <i>P. falciparum</i> No. and %)
1	Shah Rukn-e-Alam	230	42	30	10	2
2	Chowk Kumharan Wala	280	106	77	20	9
3	Delhi Gate	125	45	25	15	5
4	Pak Gate	160	62	40	14	8
5	Haram Gate	100	35	22	8	5
6	Bohar Gate	74	20	10	7	3
7	Daulat Gate	82	22	11	8	3
8	Shuja Abad City	618	290	145	100	45
9	Jalal Pur Pirwala	504	118	79	26	13
10	Multan Cantt.	172	65	34	25	6
11	Dera Adda	110	50	31	15	4
12	Old Shuja Abad Road	82	36	23	10	3
13	Manzoor Abad Chowk	168	90	62	20	8
14	Gul Zaib Colony	124	65	40	20	5
15	Nawan Shehr	116	58	35	19	4
16	Hassan Abad	60	17	9	6	2
17	Jahangir Abad	240	95	65	22	8
18	Ghanta Ghar	180	82	45	32	5
19	Pul Shawala	130	70	47	20	3
20	Jalil Abad	215	110	75	28	7
Total		3770	1478 (39.20%)	905 (61.23%)	425 (28.75%)	148 (10.01%)

Table 2. Month-wise prevalence of Malarial infection in Southern Punjab (District Multan)

Month	No. of Slides Examined	Total No. of Positivity	<i>Plasmodium vivax</i> No. and %	<i>Plasmodium falciparum</i> No. and %	Mixed Species (<i>P. vivax</i> and <i>P. falciparum</i>) No. and %
August 2015	210	85	48	25	12
September 2015	235	40	22	14	4
October 2015	122	52	30	17	2
November 2015	205	63	40	17	6
December 2015	214	105	70	25	10
January 2016	274	46	30	12	4
February 2016	198	55	33	17	5
March 2016	174	61	35	18	8
April 2016	78	45	26	16	3
May 2016	114	66	47	12	7
June 2016	110	71	49	16	6
July 2016	220	97	62	25	10
August 2016	278	141	90	33	18
September 2016	87	32	20	10	2
October 2016	90	34	19	10	5
November 2016	78	40	25	11	4
December 2016	222	99	80	13	6
January 2017	108	58	19	34	5
February 2017	98	37	23	12	2
March 2017	97	42	25	14	3
April 2017	104	40	23	13	4
May 2017	111	35	20	12	3
June 2017	128	56	31	19	6
July 2017	215	78	38	30	10
Total	3770	1478	905 (61.23%)	425 (28.75%)	148 (10.01%)

Among children from 1-10 years, 431 slides were examined, out of which 195 (45.24%) slide positivity of *Plasmodium* was to be found and the most prevalence species was observed to be *Plasmodium vivax* 140

(71.79%) as compared to with that of *Plasmodium falciparum* 39 (20%) and mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) 16 (8.20%). In the age group of 11-20 years 736 slides were examined and

260 (35.32%) slide positivity was to be found and the commonest species of malarial parasites observed was *Plasmodium vivax* with a highest incidence of 172 (66.15%) as compared to other species of plasmodium such as *Plasmodium falciparum* 68 (26.15%) and mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) 20 (7.69%). Similarly in the age group of 21-30 years, 820 slides were examined out of which 302 (36.82%) positivity was to be found and the highest incidence of *Plasmodium vivax* 190 (62.91%) was observed as compared to that of *Plasmodium falciparum* 90 (29.80%) and mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) 22 (7.28%). In the age group of 31-40 years 863 slides were examined and only 306 (35.45%) slides were found to be positive, out of which the highest incidence of *Plasmodium vivax* 197 (64.37%) was the commonest species of malarial parasites as compared to *Plasmodium falciparum* 81 (26.47%) and mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) 28 (9.15%), while in the age group of 41 years and above 920 slides were observed and 415 (45.10%) slides were found to be positive, out of which 206 (49.63%) the most common species of malarial parasites was *Plasmodium vivax* as compared to that of *Plasmodium falciparum* 147 (35.42%) and

mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) 62 (14.93%) (Table 3).

It was also observed that there is seasonal variations in infection of different plasmodium species, as the highest rate of infection of *Plasmodium vivax* 150 (73.52%) was noted in December while lowest in September 42 (58.33%) while infection of *Plasmodium falciparum* was found to be highest in August 58 (25.66%) and lowest in May 24 (23.76%) as compared to the infection of mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) highest in the month of August 30 (13.27%) and lowest in the month of February 7 (7.60%) (Table 4). Infection in males was 850 (57.51%), out of which *Plasmodium vivax* was highest 508 (59.76%) as compared to that *Plasmodium falciparum* 248 (29.17%) and mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) 94 (11.05%) while in females 628 (42.48%) positivity was to be found, out of which *Plasmodium vivax* was highest 397 (63.21%) as compared to that of *Plasmodium falciparum* 177 (28.18%) and mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) 54 (8.59%) (Table 5). The comparison of these results with those of other studies which have been done in Pakistan is in discussion.

Table 3. Age-wise overall prevalence of Malarial infection in accordance to Total Number and Percentage in Southern Punjab (District Multan) from August 2015 July 2017

Sr. No.	Age (Years)	Total Number of Slides Examined	Total Number of Positivity	Overall % Infection	Infection by <i>Plasmodium vivax</i> number and %age	Infection by <i>Plasmodium falciparum</i> number and %age	Mixed species (<i>Plasmodium vivax</i> and <i>Plasmodium falciparum</i>) number and %age
1	1-10	431	195	45.24%	140 (71.79%)	39 (20%)	16 (8.20%)
2	11-20	736	260	35.32%	172 (66.15%)	68 (26.15%)	20 (7.69%)
3	21-30	820	302	36.82%	190 (62.91%)	90 (29.80%)	22 (7.28%)
4	31-40	863	306	35.45%	197 (64.37%)	81 (26.47%)	28 (9.15%)
5	41-above	920	415	45.10%	206 (49.63%)	147 (35.42%)	62 (14.93%)
Total		3770	1478	39.20%	905 (61.23%)	425 (28.75%)	148 (10.01%)

Table 4. Month-wise prevalence of Malarial infection in accordance to Total Number and percentage in Southern Punjab (District Multan) from August 2015 to July 2017

Month	Total number of slides examined	Total number of positivity	<i>Plasmodium vivax</i> number and %age	<i>Plasmodium falciparum</i> number and %age	Mixed species (<i>Plasmodium vivax</i> and <i>Plasmodium falciparum</i> number and %age)
August 2015 & 2016	210+278=488	85+141=226	48+90=138 (61.06%)	25+33=58 (25.66%)	12+18=30 (13.27%)
September 2015 & 2016	235+87=322	40+32=72	22+20=42 (58.33%)	14+10=24 (33.33%)	4+2=6 (8.33%)
October 2015 & 2016	122+90=212	52+34=86	30+19=49 (56.97%)	17+10=27 (31.39%)	5+5=10 (11.62%)
November 2015 & 2016	205+78=283	63+40=103	40+25=65 (63.10%)	17+11=28 (27.18%)	6+4=10 (9.70%)
December 2015 & 2016	214+222=436	105+99=204	70+80=150 (73.52%)	25+13=38 (18.62%)	10+6=16 (7.84%)
January 2016 & 2017	274+108=382	46+58=104	30+19=49 (47.11%)	12+34=46 (44.23%)	4+5=9 (8.65%)
February 2016 & 2017	198+98=296	55+37=92	33+23=56 (60.86%)	17+12=29 (31.52%)	5+2=7 (7.60%)
March 2016 & 2017	174+97=271	61+42=103	35+25=60 (58.25%)	18+14=32 (31.06%)	8+3=11 (10.67%)
April 2016 & 2017	78+104=182	45+40=85	26+23=49 (57.64%)	16+13=29 (34.11%)	3+4=7 (8.23%)
May 2016 & 2017	114+111=225	66+35=101	47+20=67 (66.33%)	12+12=24 (23.76%)	7+3=10 (9.90%)
June 2016 & 2017	110+128=238	71+56=127	49+31=80 (62.99%)	16+19=35 (27.55%)	6+6=12 (9.44%)
July 2016 & 2017	220+215=435	97+68=175	62+38=100 (57.14%)	25+30=55 (31.42%)	10+10=20 (11.42%)
Total	2154+1616=3770	786+692=1478 (39.20%)	492+413=905 (61.23%)	214+211=425 (28.75%)	80+68=148 (10.01%)

Table 5. Sex-wise prevalence of Malarial Infection in accordance to Total Number and Percentage in Southern Punjab (District Multan) from August 2015 to July 2017

Total Number of Slides Examined	Total Number of Positivity	Number of Male Positive			Number of Female Positive		
		<i>Plasmodium vivax</i>	<i>Plasmodium falciparum</i>	Mixed Species (<i>Plasmodium vivax</i> and <i>Plasmodium falciparum</i>)	<i>Plasmodium vivax</i>	<i>Plasmodium falciparum</i>	Mixed Species (<i>Plasmodium vivax</i> and <i>Plasmodium falciparum</i>)
3770	1478	508 (59.76%)	248 (29.17%)	94 (11.05%)	397 (63.21%)	177 (28.18%)	54 (8.59%)
		850 (57.51%)			628 (42.48%)		

Discussion

In Pakistan, malaria is considered to be a continuous severe public health problem [18]. From the Eastern Mediterranean region in 2010, over one million malarial cases through microscopy confirmed were reported of which 25% came from Pakistan [1]. Approximately 325 million people affect through malaria and causes more than a million of deaths per year throughout the world. *Plasmodium falciparum* has high mortality as compared to other plasmodium and it causes several diseases such as algid malaria, renal failure and cerebral malaria [5].

This survey was conducted to provide up to date information about malarial prevalence throughout District Multan. In this analysis, samples were collected from patients suffering from malaria with symptoms and one limitation is the potential for district Multan region in accordance to treatment seeking behaviour and centres for access to treatment. But unfortunately prior to diagnosis information on treatments taken was not collected and could be included in this study. In addition to this, season variations were also to be noted in the district areas of Multan where the highest rate of infection of *Plasmodium vivax* in December, *Plasmodium falciparum* in August and mixed

species (*Plasmodium vivax* and *Plasmodium falciparum*) in August. Despite this information, the data presented in this study is more comprehensive and shows current characterization of prevalence of malaria in Multan District than has previously been available.

The prevalence of *Plasmodium vivax* was observed as highest (61.23%) as compared to that of *Plasmodium falciparum* (28.75%) and mixed species (*Plasmodium vivax* and *Plasmodium falciparum*) (10.01%) in the present study. Many researchers reported higher incidences of *Plasmodium vivax* (60.4%), *Plasmodium falciparum* (37.6%) in District of Multan, while in districts Quetta (66.7% *Plasmodium vivax*, 30.8% *Plasmodium falciparum*), Muzafarabad (90.3% *Plasmodium vivax*, 48.2% *Plasmodium falciparum*) and Kohlu (58.8% *Plasmodium vivax* and 41.2% *Plasmodium falciparum*) [13, 19-21] respectively.

In the present analysis, *Plasmodium vivax* 71.79%, 66.15%, 62.91%, 64.37% and 49.63% was observed in the patients of the age group 1-10, 11-20, 21-30, 31-40, and 41 years & above respectively. Similarly, *Plasmodium falciparum* 20%, 26.15%, 29.80%, 26.47% and 35.42% was observed in the age group 1-10, 11-20, 21-30, 31-40, and 41 years & above, while mixed species

(*Plasmodium vivax* and *Plasmodium falciparum*) 8.2%, 7.69%, 7.28%, 9.15% and 14.93% was observed in the age group 1-10, 11-20, 21-30, 31-40, and 41 years & above respectively. Similarly [22] found 8.5% and 73.8% in the patients of the age group of 11-20 years and 21 years & above respectively in the Kashmiri settled in Muzaffarabad and *Plasmodium falciparum* 18%, 22.4%, 26.1% and 33.5% in the age group of 1-10, 11-20, 21-30 and 31-40 years was observed in the refugees of Zhob respectively [23].

In the malarial patients of Iran, slide positivity rate was to be reported 9.7% [24]. 43.3, 33.3; 16.1, 15.5; 33.9, 11.5; 25.5, 28.5; 27.2, 41.7% slide positivity rate of *Plasmodium vivax* and *Plasmodium falciparum* in Kharan, Quetta, Qila Abdullah, Mastung and Khuzdar rural and urban areas respectively by [13, 14, 19-21, 27]. In another study in 33 different localities of Quetta (city) visited showed that *P. vivax* was found to be the most common species with the highest rate of frequency (84.53%) as compared to that of *P. falciparum* (6.02%) in children [28]. These results are similar with our findings.

In this study, mixed infection of 8.2%, 7.69%, 7.28%, 9.15% and 14.93% was observed. Mixed infection on 2.4% was observed in Multan district by [25]. However, in Quetta district, the same 2.4% was observed [26].

During this study no case of *Plasmodium ovale* or *Plasmodium malariae* infection was to be observed and the same were the observations of [25] in District Multan.

Conclusion

Pakistan is facing several challenges in the control and management of malaria including lack of diagnostic facilities, misdiagnosis and use of presumptive treatments. The results of this study indicate that Plasmodium infection in Pakistan are largely attributed to *Plasmodium vivax* but *Plasmodium falciparum* and mixed species of *Plasmodium*

infections are also prevalent. In addition to this, regional variation in the prevalence and species composition of malaria is very high. So, malaria control efforts should be focused where malaria prevalence is highest with emphasis on improving species diagnosis.

Authors' contributions

Conceived and designed the experiments: M Zafar, Laboratory Experiment: M Zafar & Asmatullah, Data Collection: MKA Khan & MZ Khan, Analysis of Data: IM & S Masud, Experiment Supervision: Asmatullah, Paper Writing: M Zafar.

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