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Prevalence and distribution of malaria parasites in general population of district Dir Lower, Khyber Pakhtunkhwa, Pakistan

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Abstract

Malaria, the disease caused by protozoan parasite *Plasmodium* is moderately endemic in Pakistan. This study was conducted from October 2013 to September 2014 with aim to determine the prevalence and distribution of malarial parasites in general population of District Dir Lower, Khyber Pakhtunkhwa, Pakistan. The data were collected from government hospitals and private laboratories of the district and analysed through SPSS software. Chi-square test was employed to find association of malaria with tested variables and P-value below 0.05 was considered significant. A total of 821 patients suspected for malaria were enrolled in this study among which 324 (39.5%) were found positive for malaria parasites through microscopy. The species of *Plasmodium* detected were *Plasmodium vivax* (30.1%) and *Plasmodium falciparum* (9.4%). Mixed infection with both species was not detected. Prevalence of *P. vivax* in males was 24.5% and in females was 15.0% while that of *P. falciparum* was 6.3% and 3.0% respectively. Prevalence of both species was highest (8.3% *P. vivax* and 2.7% *P. falciparum*) in subjects aged 21-30 years. *P. vivax* was most prevalent in the month of October while *P. falciparum* was in March. Prevalence of *P. vivax* ranged from 2.8% in Tehsil Munda to 6.9% in Tehsil Timergara while that of *P. falciparum* varied from 0.5% in Tehsil Samarbagh to 2.3% in Timergara. Association of malaria was significant only with age of the host and not with any other tested variable. In conclusion, male population was more infected and *P. vivax* was the predominant species of *Plasmodium* in study area.

Keywords: Dir Lower, Malaria, *Plasmodium falciparum*, *Plasmodium vivax*, prevalence

1. Introduction

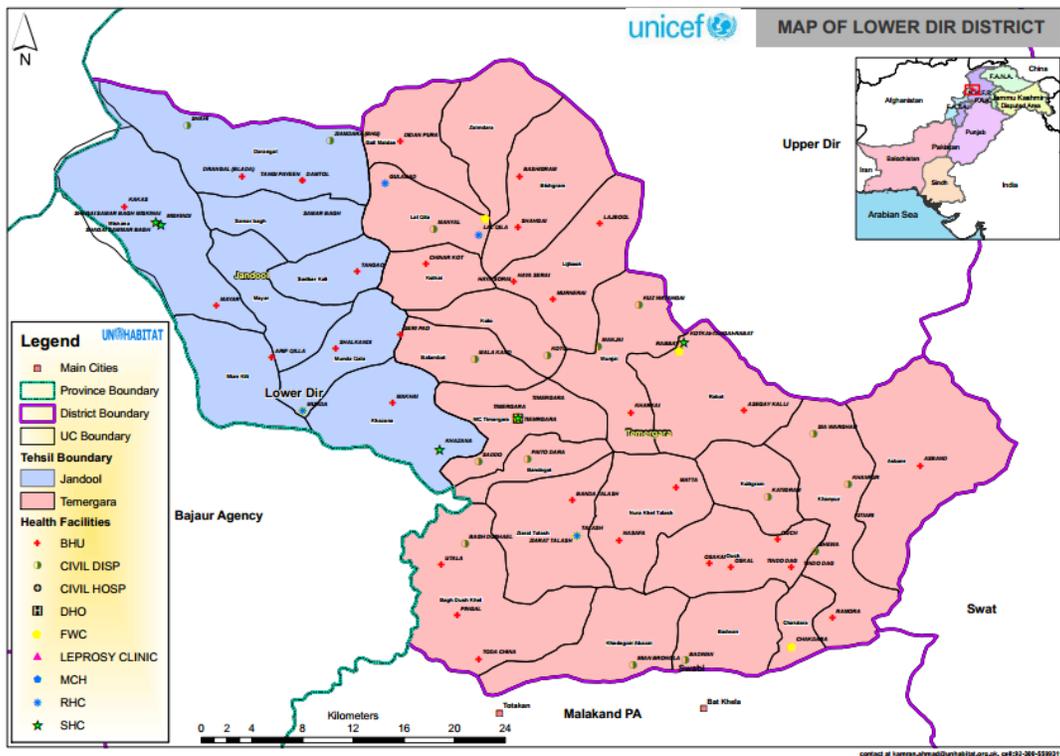
Malaria is the most devastating and widespread of all parasitic diseases in the world and is a major cause of morbidity and mortality in developing countries [1]. Four species of *Plasmodium* i.e. *P. falciparum*, *P. vivax*, *P. malariae* and *P. ovale* cause malaria in humans [2]. These parasites infect the RBCs of blood and cause anemia, nausea and fever [3]. Mosquitoes act as vector for the spread of *plasmodium*. The epidemiology of malaria depends on the vector's biology, the *plasmodium* species, the human host and on the socio-economic conditions of the regions [4]. Nowadays, malaria is considered as a tropical disease [3]. Malaria is quiet common in Pakistan and is found primarily in the provinces of Khyber Pakhtunkhwa, Baluchistan, Sindh and the federally administered tribal areas. Malaria in Pakistan is mainly caused by *P. vivax* followed by *P. falciparum*. A well-established programme is working for the control of malaria in Pakistan, but still about fifty thousand deaths are attributed to malaria annually. Of these, 37% are estimated to occur along the Afghanistan and Iran borders. The number of malaria cases is increasing in Pakistan. This increase in malaria cases may be due to floods in previous years which affected about twenty million people in more than sixty districts. Also the rate of infection with *P. falciparum* has increased due to increase resistance of *P. falciparum* to Chloroquine and also to continuous influx and presence of Afghan refugees as *P. falciparum* is more prevalent in Afghanistan [5]. Malaria can be controlled by performing malaria surveys on local bases. Prompt and accurate diagnosis is a key factor for the disease management. This helps in finding out the impact of disease on the health status of local population and also reduces the unnecessary use of anti-malarial drugs as drug selection for treatment of malaria depends on species of malaria parasite present in suspected patients [6]. The current study was planned to find out the prevalence and distribution of malaria parasites in general population of District Dir Lower, Khyber Pakhtunkhwa Pakistan.

2. Materials and Methods

2.1 Study area

Data for this study was collected from DHQ hospital Timergara and other private laboratories in District Dir Lower. The district of Dir Lower is located at 34-35 N° and 71-72 E° in the north of Pakistan along the Pakistan and Afghanistan border. It is 1583 km² in area and is divided into

seven Tehsils including Tehsil Adenzai, Timergara, Balambat, Munda, Samar bagh, Maidan and Khall. Population of Dir Lower as per 1998 census is 717649. Topography of the district is hilly. The summer is moderate, the winter is cold and rain fall is received throughout the year [7].



2.2 Study population

The study was carried out from October 2013 to September 2014. Patients of all age groups who visited the hospitals with signs and symptoms of malaria (fever, chills, headache, sweats, fatigue, nausea and vomiting) and advised test by the doctor were included in the study. A printed proforma was filled for each patient at the time of blood collection to have information about the name, address, sex and age of the host.

2.3 Microscopy

Blood samples were examined through microscopy. Finger tip of each patient was cleaned with methylated spirit and pricked with disposable lancet. Both thick and thin blood smears were prepared on the same slide, fixed with methyl alcohol, stained with Giemsa stain and examined under 100X oil immersion objective.

2.4 Data analysis

Data were analysed with SPSS version-16 (SPSS Inc., Chicago, IL, USA). Chi-square test was used to find association of malaria with tested variables and P-value of less than 0.05 was considered statistically significant.

3. Results

3.1 Species-wise prevalence of malaria

A total of 821 blood samples were tested during the present study period of which 324 were found infected with malaria parasites showing an overall 39.5% prevalence of malaria. Of the total 324 positive samples, 247 (30.1%) were infected with *Plasmodium vivax* while 77 (9.4%) were found infected with *Plasmodium falciparum*. Mixed infection of both species was not found in any blood sample. Difference between the two species was statistically non-significant as $P > 0.05$ (Table 1).

Table 1: Prevalence of *plasmodium* species in general population of District Dir Lower, Khyber Pakhtunkhwa, Pakistan during October 2013-September 2014.

		<i>Plasmodium falciparum</i>		Total n (%)
		Negative n (%)	Positive n (%)	
<i>Plasmodium vivax</i>	Negative n (%)	497 (60.5)	77 (9.4)	574 (69.9)
	Positive n (%)	247 (30.1)	0 (0.0)	247 (30.1)
	Total n (%)	744 (90.6)	77 (9.4)	821 (100)

$\chi^2 = 36.56; df = 1; P = 1.47$

3.2 Sex-wise prevalence of malaria

Of all the study participants, 429 (52.3%) were males among which 201 (24.5%) were found infected while 392(47.7%)

were females in which 123 (15.0%) were found positive for malaria parasites. The difference was statistically non-significant as P-value was greater than 0.05 (Table 2).

Table 2: Sex-wise prevalence of malaria in general population of District Dir Lower, Khyber Pakhtunkhwa, Pakistan during October 2013-September 2014.

Sex of host	Samples tested n (%)	<i>Plasmodium vivax</i> Positive n (%)	<i>Plasmodium falciparum</i> Positive n (%)	Total Positive n (%)
Male	429 (52.3)	149 (18.1)	52 (6.3)	201 (24.5)
Female	392 (47.7)	98 (11.9)	25 (3.0)	123 (15.0)
$\chi^2 = 21.75$; $df = 2$; $P = 1.88$				

3.3 Age-wise prevalence of malaria

All the tested subjects were divided into different age groups. Majority of them (32.8%) were aged 21-30 years. Both *P. vivax* and *P. falciparum* infection was recorded in people of all ages and their prevalence varied in different age groups. Prevalence of both *plasmodium* species was highest in

humans aged 21-30 years. Slide positivity rate of *P. vivax* ranged from 1.1% in age group 1-10 years to 8.3% in 21-30 years while that of *P. falciparum* from 0.2% in people over 60 years of age to 2.7% in 21-30 years. There was significant difference ($P < 0.05$) regarding prevalence of malaria and different age groups (Table 3).

Table 3: Prevalence of malaria in different age groups among general population of District Dir Lower, Khyber Pakhtunkhwa, Pakistan during October 2013-September 2014.

Age group (years)	Samples tested n (%)	<i>Plasmodium vivax</i> Positive n (%)	<i>Plasmodium falciparum</i> Positive n (%)	Total Positive n (%)
1-10	56 (6.8)	09 (1.1)	08 (1.0)	17 (2.1)
11-20	138 (16.8)	34 (4.1)	12 (1.5)	46 (5.6)
21-30	269 (32.8)	68 (8.3)	22 (2.7)	90 (11.0)
31-40	154 (18.8)	49 (6.0)	15 (1.8)	64 (7.8)
41-50	121 (14.7)	53 (6.5)	12 (1.5)	65 (7.9)
51-60	50 (6.1)	23 (2.8)	06 (0.7)	29 (3.5)
Above 60	33 (4.0)	11 (1.3)	02 (0.2)	13 (1.6)
$\chi^2 = 32.09$; $df = 12$; $P = 0.001$				

3.4 Month-wise prevalence of malaria

Prevalence of malaria cases was highest in the months of October (5%), September (4.4%) and August (4.3%) and

lowest in the months of January (1.9%) and February (2.1%). However, the difference of malaria and different months was statistically non-significant (Table 4).

Table 4: Month-wise prevalence of malaria in general population of District Dir Lower, Khyber Pakhtunkhwa, Pakistan during October 2013-September 2014.

Month	Samples tested n (%)	<i>Plasmodium vivax</i> Positive n (%)	<i>Plasmodium falciparum</i> Positive n (%)	Total Positive n (%)
October	72 (8.8)	36 (4.4)	05 (0.6)	41 (5.0)
November	86 (10.5)	14 (1.7)	09 (1.1)	23 (2.8)
December	53 (6.5)	18 (2.2)	04 (0.5)	22 (2.7)
January	70 (8.5)	11(1.3)	05 (0.6)	16 (1.9)
February	67 (8.2)	10 (1.2)	07 (0.9)	17 (2.1)
March	78 (9.5)	22 (2.7)	10 (1.2)	32 (3.9)
April	67 (8.2)	16 (1.9)	05 (0.6)	21 (2.6)
May	53 (6.5)	18 (2.2)	04 (0.5)	22 (2.7)
June	64 (7.8)	24 (2.9)	06 (0.7)	30 (3.7)
July	70 (8.5)	24 (2.9)	05 (0.6)	29 (3.5)
August	105 (12.8)	29 (3.5)	06 (0.7)	35 (4.3)
September	36 (4.4)	25 (3.0)	11 (1.3)	36 (4.4)
$\chi^2 = 103.6$; $df = 22$; $P = 1.48$				

3.5 Area-wise prevalence of malaria

Similarly, both *plasmodium* species were found to be prevalent in all the seven Tehsils of the district. Slide positivity rate of malaria differed in different Tehsils but comparison by χ^2 -test indicated the difference to be

statistically non-significant ($P > 0.05$). Rate of positive cases in different Tehsils in descending order was Timergara > Balambat > Khall > Lal Qilla > Adenzai > Munda > Samar Bagh (Table 5).

Table 5: Prevalence of malaria in different Tehsils of District Dir Lower, Khyber Pakhtunkhwa, Pakistan during October 2013-September 2014.

Tehsil	Samples tested n (%)	<i>Plasmodium vivax</i> Positive n (%)	<i>Plasmodium falciparum</i> Positive n (%)	Total Positive n (%)
Adenzai	80 (9.7)	27 (3.3)	10 (1.2)	37 (4.5)
Timergara	145 (17.7)	57 (6.9)	19 (2.3)	76 (9.3)
Balambat	159 (19.4)	43 (5.2)	19 (2.3)	62 (7.6)
Munda	91 (11.1)	23 (2.8)	07 (0.9)	30 (3.7)
SamarBagh	66 (8.0)	24 (2.9)	04 (0.5)	28 (3.4)
Lal Qilla	182 (22.2)	36 (4.4)	09 (1.1)	45 (5.5)
Khall	98 (11.9)	37 (4.5)	09 (1.1)	46 (5.6)
$\chi^2 = 36.61$; $df = 12$; $P = 2.57$				

4. Discussion

Prevalence of malaria among humans of District Dir Lower from October 2013 to September 2014 recorded in this study was 39.5%. This is substantially higher than the 12.29% prevalence rate reported in humans from the same district two years earlier^[8]. This shows an increase in the number of malaria cases among humans in District Dir Lower. However, *P. vivax* was recorded as the predominant species followed by *P. falciparum* and no case of *P. malariae* and *P. ovale* was recorded during this study. This is in agreement with the studies previously conducted in the same district^[8, 9]. Other authors also reported *P. vivax* as the major cause of malaria among humans in Pakistan^[10-14]. Reason for this may be that *P. vivax* is mainly found in subtropical and temperate regions^[15].

Sex-wise prevalence showed that malaria was more common in males (24.5%) than females (15.0%) in this study. This may be due to the fact that in the studied area, males have more chances of being bitten by the mosquitoes because they more often go and work outside homes. Also the males are not so covered as females. Males as the predominant victim of malaria were also reported in Gadap region Pakistan^[16]; in District Buner, Khyber Pakhtunkhwa, Pakistan^[11]; in Lal Qilla, Khyber Pakhtunkhwa, Pakistan^[9]; in District Charsadda, Khyber Pakhtunkhwa, Pakistan^[17]; in District D.I Khan, Pakistan^[18]; in District Bannu Khyber Pakhtunkhwa, Pakistan^[12]; in District Ziarat and Sanjavi, Balochistan, Pakistan^[19]; in Pakistani areas bordering with Iran^[20].

In this study, significant association of malaria was found with age of the host in both males and females. Highest rate of infection (11.0%) was recorded in people aged 21-30 and lowest (1.6%) in people above 60 years. This is also self-explanatory as in our society the people of young age are more active and thus more often bitten by the mosquitoes compared to elder aged ones. Highest rate of malaria in age group 21-30 was also recorded in general population of District Bannu of Khyber Pakhtunkhwa Pakistan^[12].

The current study showed that malaria cases were more frequent during the months of August, September and October i.e. autumn season and less common during the months of January and February i.e. winter season. This is in accordance with the study conducted in this district a couple of years ago^[8]. Possible reasons for this high prevalence of malaria in autumn may be raining during monsoon and favorable temperature during these months which provide suitable conditions for the growth of mosquitoes and thus increased in malaria cases^[21, 22]. Low temperature and dry season during winter hinders the sporogonic development^[23]. Local irrigation practices may also influence the prevalence of malaria during different seasons of the year^[24].

5. Conclusion

It was concluded from this study that malaria in Dir Lower is caused by *Plasmodium vivax* and *Plasmodium falciparum* with *P. vivax* being the most prevalent. Males are more infected than females. Malaria is common in middle aged people of the study area.

6. Acknowledgement

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7. Competing interests

The authors declare that they have no conflict of interest.

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