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Research Article

Prevalence of Malarial Parasites in residents of District Kasur

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Abstract | Malaria is a fever-inducing parasitic infection characterized by a single-celled eukaryotic organism *Plasmodium* that spreads from person to person by the bite of the female mosquito. The most prevalent species of *Plasmodium* in Pakistan are *Plasmodium vivax* and *Plasmodium falciparum*. The aim of current work was to determine the prevalence of malarial parasites in residents of District Kasur. Current study recruited both male and female subjects since malarial infections are not gender dependent. Blood samples were collected from suspected malarial patients visiting hospitals of District Kasur over a period of 1 year (March, 2018 - June, 2019). Rapid Diagnostic Tests (RDTs) were used for malarial diagnosis. From a total of 400 blood samples, 135 (34%) samples presented specific *P. vivax* and *P. falciparum* antibodies. Out of the 135 positive cases, 91 (67%) were identified as *P. vivax* infections and 44 (33%) were identified as *P. falciparum*. Prevalence was higher (60%) in males than in females (40%). Moreover, prevalence was higher (49%) in 31-45 years' age group of males which maybe because the males in this age group in District Kasur work in factories, mines, fields and outside areas rendering them more vulnerable to mosquito bites. Meanwhile in females, prevalence was higher (39%) in 16-30 years' age group. It was also observed that malaria caused low blood pressure in (72%) female diagnosed with malaria. Seroprevalence was higher in lower socioeconomic localities and in rural areas of Kasur where proper sewerage system was not available. The limited income resources of middle class or lower-class families (5,000-10,000 PKR/month) were unable to afford preventive measures against mosquitos such as repellents, DEETs, insecticide treated bed nets etc. Present study revealed that the burden of malaria was high in male population of rural Kasur and more attention is required to overcome the prevalence of malaria in this region.

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1. Introduction

Malaria is considered the World's deadliest disease which keeps on demanding a considerable toll of human life and is a notable threat to the population of the World's tropical and temperate areas (Ekwunife *et al.*, 2011). Malaria affects

almost 3.3 billion people Worldwide. Malaria cases and fatalities were as high 249 million in the year 2022 as compared to 244 million cases in 2021 (World Health Organization, 2022). The word malaria is misnomer and has originate from Italian words "mala" signify "terrible" and "ayia" signify "air" since the disease originated from fetid marshes (Reiter, 2000).

The causative agent of malaria is *Plasmodium* which is an intracellular unicellular protozoa parasite. *P. falciparum*, *P. knowlesi*, *P. malariae*, *P. ovale* and *P. vivax* are the most common type prevalent in humans (Kantele and Jokiranta, 2010). *P. falciparum* causes the most lethal form of malaria, whereas *P. vivax* is less dangerous but is more ubiquitous. The other three species are less frequent (World Health Organization, 2022). In Asia about 46% of population is in danger of *P. falciparum* malaria alongside high transmission rates for *P. vivax* malaria (Marianne, 2013). According to World Health Organization, in Pakistan almost 57,188 malarial cases were accounted for every population of 179,160,100 (World Health Organization, 2015). In Pakistan 23 *Anopheline* species have been reported (Ilahi and Suleman, 2013). Among these *An. culicifacies* is considered a prevalent vector in rural areas whereas *An. stephensi* is a more prevalent malaria vector in urban areas of Pakistan (Mahmood *et al*., 1984; Jahan and Hussain, 2011).

In India the reported ratio of *P. falciparum* to *P. vivax* was revealed to be 49:51, with multi-species infections induced by these two parasites accounting for 13% of all infections (Siwalet *et al*., 2018). *P. falciparum* was found in 91% patients in East China who were presented with symptoms of malaria, whereas *P. vivax* was found in 8% and *P. malariae* was found in only 1% of the cases (Zhang *et al*., 2017). According to a previous study (Provost, 2011) Ivory Coast (85.29%) and Angola (66.93%) had the highest death rates per 100,000 people attributed to malaria.

Malaria is endemic in 109 countries including Pakistan with at least 5 million reported cases of malaria annually (Yasinzai and Kakar, 2012). In a 2008 study conducted in Karachi the annual incidence of *P. falciparum* were 46.5%, *P. vivax* were 51.8%, *P. malariae* were 0.4%, and the ratio of mixed infestation (both *P. falciparum* and *P. vivax*) were 1.3% (Beg *et al*., 2008). In Baluchistan the reported prevalence of malaria in the year 2004 was 5.7%, 1.0%, 5.3%, 1.1%, 9.6%, 27.2%, 13.3%, 7.3% and 13.5%, whereas in the year 2005 it was 4.7%, 0.5%, 6.6%, 1.5%, 12.9%, 32.4%, 10.2%, 7.5% and 13.5%, and in the year 2006 it was 5.7%, 3.8%, 17.5%, 2.5%, 42.2%, 29.5%, 7,6.8%, and 12.9% in Lasbella, Qilla Abdullah, Mastung, Khuzdar, Kohlu, Zhob, Kharan, Sibi and Turbat respectively (MCPB, 2004; MCPB, 2005; MCPB, 2006).

The goal of current study was to determine the severity of malaria transmission and its seasonal influence as well as the seroprevalence of *plasmodium* species in male and female subjects residing in rural and urban areas of District Kasur.

2. Materials and Methods

2.1. Study Area

District Kasur is about 55 km towards the South of Lahore situated at 31. 12º North Latitude, 74.45º East Longitude and elevated at about 201 meters above the sea level. It spreads over an area of about 3995 Km² with about 3.4 million inhabitants. The climate is hot in summer and comparatively cold in winter. May and June are the hottest months. The average temperature ranges between 19-31ºC, average relative humidity is about 57% with 62 mm of average annual rain fall. This district was selected on the basis of

intensive rice irrigation areas, high malaria endemicity and climatic conditions favorable for mosquito breeding.

2.2. Experimental Design

A Total of 400 blood samples were collected from male and female subjects recruited from different hospitals of District Kasur (District Head Quarter Hospital, Shareef Medical Complex, Wali Hospital, Al Shifa Hospital and Nawaz Memorial Hospital Kasur) with the help of hospital's laboratory staff and after written informed consents. Laboratory and research work were performed in Parasitology lab at the Department of Zoology, Lahore College for Women University, Lahore (LCWU). Blood samples were collected over a period of 1 year, between June, 2018 to June, 2019. Data was collected from patients by filling comprehensive questionnaire. Rapid Diagnostic Tests (RDTs) technique was used to analyze the blood samples for positivity of malarial parasite. Malaria fast screening tests, often known as "dipsticks" or MRDDS (Malaria Rapid Diagnostic Device) were employed for the diagnosis of malaria by detecting the presence of malarial parasites in human blood. RDTs are a viable alternative to clinical diagnosis or microscopy in situations when high-quality microscopy services are unavailable.

2.3. Gender wise prevalence

The gender wise prevalence of malarial parasites was determined by following formulae;

$$\text{Percentage of malarial parasites in males} = \frac{\text{Number of male positive patients}}{\text{Total number of malaria patients}} \times 100$$

$$\text{Percentage of malarial parasites in females} = \frac{\text{Number of female positive patients}}{\text{Total number of malaria patients}} \times 100$$

2.4. Statistical analysis

Chi square test was applied between all positive and negative cases and also on all positive cases according to age group, weight, socioeconomic status, blood pressure, family status, income group and seasonal variations at the time of sampling. $p<0.05$ was considered the accepted significance level.

3. Results

A total 400 samples were collected from both males (n=230) and females (n=170) in District Kasur. Out of the total 400 blood samples collected from suspected cases, 135 (34%) tested positive for *P. falciparum* and *P. vivax*; while 265 (66%) tested negative for malarial parasites. The anthropometric characteristics of studied population along with univariate, multivariate (Chi-square ANOVA) analysis and risk factors associated with malarial parasites are provided in are provided in Table 1.

Table 1: Anthropometric characteristics of studied population.

	Infected/ examined	Prevalence %	Chi-square	*p-value*	ANOVA	*p-value*
Gender						
Males	81/400	20	43.29	0.34	4.92	0.21
Females	54/400	13.5				
Income (PKR)						
Gender	**Male**	**Female**	**Male**	**Female**		
5,000-15,000	12/81	4/54	15	7	54.36	0.24	40.96	0.34
16,000-25,000	21/81	4/54	26	7				
26,000-35,000	7/81	3/54	8	6				
36,000-45,000	2/81	1/54	2	1.8				
<45,000	2/81	0/54	2	0				

$p\leq0.01$**= Highly significant; $p\leq0.05$*=Significant and $p>0.05$= Non-significant

3.1. Prevalence of malarial parasites (P. vivax and P. falciparum)

Among the 135 positive samples, 91 (67%) suffered from *P. vivax* and 44 (33%) suffered from *P. falciparum.* No mixed cases of malarial parasites were found (Figure 1).

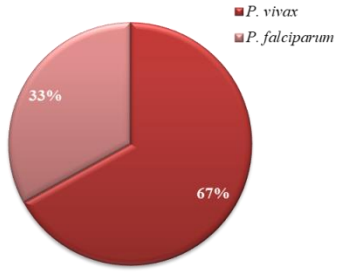

Figure 1: Prevalence of malarial parasites.

3.2. Age-wise distribution

The subjects recruited for current study were separated into four age groups (1-15 years, 16-30 years, 31-45 years and >45 years) (Table 2). About 10 (12%) of the positive samples were from total 81 (60%) male positive samples between the ages of 1 and 15, 26 (33%) of the positive results were between the ages of 16 and 30, 40 (49%) of the positive test were between the ages of 31 and 45, and 5 (6%) positive samples were above 45 years. Six (11%) of the positive samples were from total 54 (40%) female positive samples between the ages of 1-15years, 21 (39%) positive samples were between the ages of 16-30 years, 16 (30%) positive results were between the ages of 31-45 years, and 11 (20%) positive samples were >45 years.

Table 2: Age-wise distribution of studied population

	Infected/ examined		Prevalence %		Chi-square	*p-value*	ANOVA	*p-value*
Age (Years)								
Gender	**Male**	**Female**	**Male**	**Female**				
1-15	10/81	6/54	12.3	11	48.23	0.23	30.2	0.31
16-30	26/81	21/54	32	39				
31-45	40/81	16/54	49.7	30				
<45	5/81	11/54	6	20				

$p \leq 0.01$**= Highly significant; $p \leq 0.05$*=Significant and $p > 0.05$= Non-significant

3.3. Weight-wise distribution

Subjects recruited for present study were divided into four major weight groups (8-28 Kg, 29-49 Kg, 50-70 Kg and >70 Kg). Among 81 male positive samples, 7 (8%) were placed in weight group of 8-28 Kg, 21 (26%) were in weight group of 29-49 Kg, 29 (36%) were in weight group of 50-70 Kg and 24 (30%) were in weight group >70 Kg. Among 54 female positive samples, 8 (15%) were in weight group of 8-28 Kg, 14 (33%) were in weight group of 29-49 Kg, 21 (45%) were in weight group of 50-70 Kg and 11 (7%) were in weight group of >70 Kg (Table 3).

Table 3: Weight-wise distribution of studied population

	Infected/ examined		Prevalence %		Chi-square	*p-value*	ANOVA	*p-value*
Weight (kg)								
Gender	**Male**	**Female**	**Male**	**Female**				
8-28	7/81	8/54	8	15	23.92	0.22	0.42	0.23
29-49	21/81	14/54	26	26				
50-70	29/81	21/54	36	39				
<70	24/81	11/54	30	20				

$p \leq 0.01$**= Highly significant; $p \leq 0.05$*=Significant and $p > 0.05$= Non-significant

3.4. Blood pressure

Among the 81 male positive samples, 49 (60%) had normal blood pressure, 12 (15%) had low blood pressure and 20 (25%) had high blood pressure. However, among 54 female positive samples, 12 (22%) had normal blood pressure, 39 (72%) had low blood pressure and 3 (6%) had high blood pressure (Table 4).

Table 4: Blood pressure as a risk factor associated with prevalence of malarial parasites.

Risk factor	Infected/ examined		Prevalence %		Chi-square	*p-value*	ANOVA	*p-value*
Blood Pressure (mmHg)								
Gender	**Male**	**Female**	**Male**	**Female**				
Normal blood pressure	49/81	12/54	60	22	29.11	0.19	29.25	0.23
Low blood pressure	12/81	39/54	15	72				
High blood pressure	20/81	3/54	25	6				

$p \leq 0.01$**= Highly significant; $p \leq 0.05$*=Significant and $p > 0.05$= Non-significant

3.5. Access to sewerage facility

From the 135 total positive samples, 49 (60%) male and 38 (70%) females had access to proper sewerage facilities in their living areas and whereas the remaining 32 (40%) males and 16 (30%) females had limited or no access to proper sewerage facility (Table 5).

Table 5: Association of access to sewerage facility with prevalence of malarial parasites.

Risk factors	Infected/ examined		Prevalence %		Chi-square	*p-value*	ANOVA	*p-value*
Access to sewerage facility								
Gender	**Male**	**Female**	**Male**	**Female**				
Yes	29/81	16/54	36	30	11.96	0.15	9.26	0.24
No	52/81	38/54	64	70				

$p \leq 0.01$**= Highly significant; $p \leq 0.05$*=Significant and $p > 0.05$= Non-significant

3.6. Covered water sources

From the 135 total positive samples, 12 (15%) males and 24 (44%) females covered the containers at homes and changed water in storage tank whereas the remaining 69 (85%) males and 30 (56%) females did not (Table 6).

Table 6: Association of covered water sources with prevalence of malarial parasites.

Risk factors	Infected/ examined		Prevalence %		Chi-square	*p-value*	ANOVA	*p-value*
Covered water sources (containers and storage tanks)								
Gender	**Male**	**Female**	**Male**	**Female**				
Yes	12/81	24/54	15	44	88.26	0.02*	3.11	0.01**
No	69/81	30/54	85	56				

$p \leq 0.01$**= Highly significant; $p \leq 0.05$*=Significant and $p > 0.05$= Non-significant

3.7. Use of mosquito repellents

From the 135 total positive samples, only 4 (5%) males and 9 (17%) females reported the use of mosquito repellents whereas the remaining 77 (95%) males and 45 (83%) females did not (Table 7).

Table 7: Association of mosquito repellent use with prevalence of malarial parasites.

Risk factors	Infected/ examined		Prevalence %		Chi-square	*p-value*	ANOVA	*p-value*
Mosquito repellents								
Gender	Male	Female	Male	Female				
Yes	10/81	9/54	12	17	23.45	0.01**	15.30	0.00**
No	71/81	45/54	88	83				

$p \leq 0.01$**= Highly significant; $p \leq 0.05$*=Significant and $p > 0.05$= Non-significant

3.8. Residential area wise prevalence

Malarial infection was found more in the inhabitants of rural Kasur as compared to those who lived in the urban areas. About 69 (85%) positive male and 41 (76%) positive female subjects belonged to remote rural areas, while only 12 (15%) positive male and 13 (24%) positive female subjects resided in the metro (urban) regions. However, this difference was not significant (p=0.260) (Figure 2).

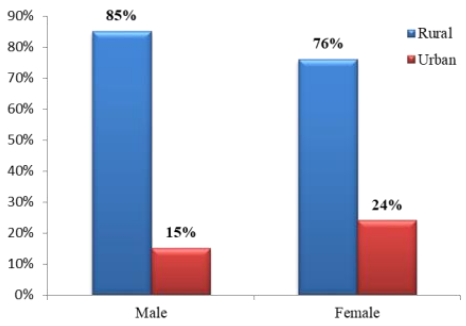

Figure 2: Residential area wise prevalence of malarial infection.

Out of 81 positive male samples, 57 (70%) were infected from *P. vivax* and 24 (30%) male patients were infected from *P. falciparum*. 57 Out of total positive *P. vivax* male patients 48 (84%) were from rural areas and remaining patients 9 (16%) positive samples were from metro (urban) regions and 24 positive *P. falciparum* male patients 21 (88%) positive samples were from remote-rural areas and remaining patients 3 (12%) positive results were from metro (urban) regions (Figure 3).

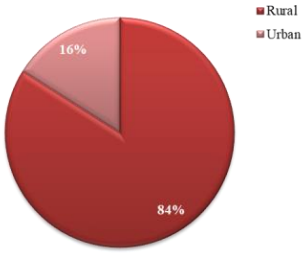

Figure 3: Residential area wise prevalence of malarial infection in males.

Out of the total 54 positive female samples, 34 (63%) were infected from *P. vivax* and 20 (37%) female patients were infected from *P. falciparum*. Out of 34 total positive *P. vivax* female 27 (79%) patients were from rural areas and remaining 7 (21%) patients were from urban regions and 20 positive *P. falciparum* female patients 14 (70%) positive samples were from remote areas and remaining patients 6 (30%) positive samples were from metropolitan (urban) regions (Figure 4).

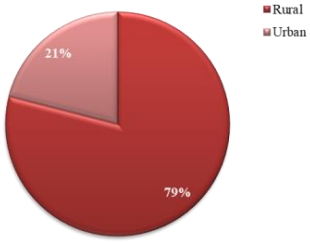

Figure 3: Residential area wise prevalence of malarial infection in females.

3.9. Seasonal Prevalence of Malaria

Current study evaluated seasonal prevalence of malaria over a period of 1 year (March, 2018 - June, 2019). Total 135 positive samples were obtained from 400 blood samples. Among 81 total male positives, 6 (7%) were obtained in March, 14 (17%) were obtained in April, 37 (46%) were obtained in May and 24 (30%) were

obtained in June. Among 54 total female positive samples, 3 (6%) were obtained in March, 14 (26%) were obtained in April, 27 (50%) were obtained in May and 10 (18%) were obtained in June. Among 6 total children positive, 0 (0%) were obtained in March, 1 (17%) were obtained in April, 3 (50%) were obtained in May and 2 (33%) were obtained in June (Table 8).

Table 8: Association of seasonal variation with prevalence of malarial parasites.

Risk factors	Infected/ examined		Prevalence %		Chi-square	*p-value*	ANOVA	*p-value*
Season (month) wise								
Gender	**Male**	**Female**	**Male**	**Female**				
Winter (November-February)	8/81	4/54	10	7	15	0.02*	19.21	0.02*
Spring (March)	0/81	1/54	0	2				
Summer (April – August)	41/81	32/54	51	59				
Autumn (September-October)	32/81	17/54	39	32				

$p \leq 0.01$**= Highly significant; $p \leq 0.05$*=Significant and $p > 0.05$= Non-significant

3.10. Species wise prevalence

The species wise prevalence of malarial parasites in rural and urban areas is provided in Table 9. It was revealed that out of the total 81 positive cases, *P. vivax* was the most prevalent malarial species (n=48) found in rural areas, followed by *P. falciparum* (n=16), whereas the incidences of mixed infections were only negligible (n=5). Similarly, *P. vivax* was the most prevalent malarial species (n=8) found in urban areas, followed by P. *falciparum* (n=1), whereas the incidences of mixed infections were only negligible (n=2) (Table 9).

Table 9: Species wise prevalence of malarial parasites.

Residential area	Species	Infected/ examined		Prevalence %		Chi-square	*p-value*	ANOVA	*p-value*
		Male	**Female**	**Male**	**Female**				
Rural	*P. falciparum*	16/81	4/54	20	7.5	45.2	0.02	4.12	0.03*
	P. vivax	48/81	14/54	59	26				
	Mixed	5/81	2/54	6	8				
Urban	*P. falciparum*	1/81	5/54	2	9				
	P. vivax	8/81	25/54	10	46				
	Mixed	2/81	4/54	3	7.5				

$p \leq 0.01$**= Highly significant; $p \leq 0.05$*=Significant and $p > 0.05$= Non-significant

4. Discussion

Current study revealed that out of 400 recruited cases of suspected malaria 34% tested positive for either *P. falciparum* or *P. vivax*, which is in accordance with the findings reported by Jahan *et al.* (2019). Among the 135 positive samples, male prevalence was found to be 60% and female prevalence was found to be 40%. These results coincide with findings presented by Ahmad *et al.* (2013) who conducted their study in Lal-Qila and reached the same conclusion. Male positive cases were at a higher prevalence due to Kasur being a rice growing area, irrigation practices were suitable for breeding of mosquitos. Males have a greater chance of exposure to mosquitos as they work in the fields or when they have to go for their jobs like factories and mills situated at adjacent areas of Kasur where sanitation and hygienic conditions are not good.

The majority of affected subjects in present study lived in rural regions where there was inadequate sanitation, low levels of education, and the existence of household pets or domestic animals indoors. When compared to individuals who did not have standing water near their dwellings, those with stagnant water had much greater malarial parasite prevalence. This suggests that the presence of stagnant water around homes constitutes a risk factor towards malaria. Results from the following study showed that presence of improper sewerage system increases the risk of malaria about 36% positive patient did not have proper sewerage system in their localities. These findings are in agreement with similar results presented by several authors (Tukur, 2010; Mokuolu *et al.*, 2016; Olagunju, 2023).

The findings of current study revealed that 88 % of malarial cases occurred in the age range of 16 to 45, which is comparable to the findings of a study by Rehman *et al.* (2011). Males in the 50-70 kg weight

range and females in the 50-70 kg weight range had a greater prevalence of malaria (36% and 45% respectively). The questionnaire filled by the patients showed that most of the people did not have exercise daily and suffered in diseases like diabetes, blood pressure, respiratory infections and other. Bad health practices caused obesity in the people resulting deficiency in immunity to fight against the disease-causing germs. Kambi *et al.* (2012) conducted study in Southwest Cameroon and found similar results where prevalence of malarial parasites was 82% which was higher in rural areas than urban areas.

Present results showed that malaria had an adverse effect on blood pressure. About 72% the females suffering from malaria had low blood pressure whereas, 22% had normal blood pressure. The male patients mostly suffered from high blood pressure and female patients from low blood pressure which is similar to Aninbogu and Olubowale (2002) who conducted their study in Nigerian population.

Present study showed that most of male patients who tested positive for malaria (77%) belonged to a low income group of 5,000-20,000PKR/month similarly; most of the female patients who tested positive for malaria (66%) belonged to the income group of 5,000-20,000PKR/month. Results showed that most of the patients from low income group and some medium income group were suffered from malarial parasite. Very few of the patients belonged to middle or high income group. The patients from lower income group don't have the purchasing power to buy mosquito nets, repellent lotion and proper medication for each individual of the family. Macintyre *et al.* (2002) also presented similar findings. Family status determines the life style of the family and hence the society as a whole. Malaria prevalence was higher in persons who had 2 or more children. The greater the number of children or family members lesser was the availability of precautionary resources such as mosquito nets and mosquito repellent lotion.

5. Conclusions

It is concluded from present work that there was a higher prevalence of malaria in male population of District Kasur as compared to the females. High prevalence in men was a result of frequent exposure to the mosquitos, unhygienic conditions in local factories and workplaces. Prevalence of malaria was higher in middle-aged men and in younger females. Most affected females suffered low and high blood pressure however only a few males presented similar symptoms. Malarial prevalence was higher in rural and backward areas of Kasur where proper sewerage and sanitation was not available. Infection was also related to the socioeconomic conditions as most of the patients belong to lower income group. It was observed that most of the patients did not know about the mosquito bite and danger of health risk of being bitten.

6. Acknowledgments

Authors would like to thank the doctors, nurses and associated hospital staff in District Kasur for their continued help, support and guidance for the duration of current study.

7. Author's Contribution

Dr. Asma Abdul Latif conceived the project and devised the plan of work. Ms. Tooba collected the samples and conducted the essential research work. All authors contributed equally to the write-up and submission of present manuscript.

8. Conflict of Interest

Authors declare no conflict.

9. Novelty Statement

Present study was a yearlong surveillance conducted to investigate the prevalence dynamics of malarial serotypes within the demographic, geographic and climatic boundaries of District Kasur. Such work is essential for the documentation of infectious diseases, assessment of their severity and planning for their prevention and or eradication.

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