The Research of Medical Science Review

Received: 7 November, 2024
Accepted: 15 November, 2024
Published: 22 November, 2024

ISSN: 3007-1208 | 3007-1216
Volume 2, Issue 3, 2024

INVESTIGATING MALARIA DYNAMICS IN DISTRICT SWAT KHYBER PAKHTUNKHWA

Muhammad Hameed Khan[1], Nida Siraj[2], Shah Fahad[3], Shafia Rehman[4], Qaisar Hayat[5], Hussain Nawaz[6] Arshad Ali[7], Arshad Ghaffar Khan[8], Mohammad Shah Faisal[*9]

[1,2,7]Department of Zoology, Entomology and Parasitology Laboratory, Faculty of Biological Sciences, Quaid-e-Azam University, Islamabad, Pakistan
[3,6]Department of Zoology, Islamia College University, Peshawar, Pakistan
[4]Department of Zoology, Parasitology Laboratory, Faculty of Biological Sciences, Quaid-e-Azam University, Islamabad, Pakistan
[5]Department of Zoology, Government AKL PG College Matta, Swat, Pakistan
[8](Supervisor)Department of Zoology, Government AKL PG College Matta, Swat, Pakistan
*[*9]Department of Zoology, Faculty of Biological Sciences, Quaid-e-Azam University, Islamabad, Pakistan*

[*9]msfaisal@bs.qau.edu.pk

ABSTRACT

Malaria is regarded as a serious public health issue due to its high rates of morbidity and fatality. Malaria is preventable and curable, but it still has a terrible effect on people's health and means of sustenance around the world. Many Plasmodium species are pathogenic to humans. Female Anopheles mosquitoes, commonly referred to as malarial vectors, bite humans and thus naturally transmit the parasite Plasmodium. This study aimed to assess the prevalence of malaria in the Swat district over three years. This study employs a cross-sectional design utilizing data from District Health Officer Malaria Laboratory, Saidu Sharif, Swat. Findings reveal of prevalence rate of 5.20% in 2019 1.00% in 2020 and 1.10% in 2021 with P. vivax predominantly affecting males. The COVID-19 lockdowns in 2020 temporarily reduced malaria cases, but prevalence rebounded in 2021. These results show the need for ongoing malaria surveillance and highlight the impact of external factors such as the pandemic on disease transmission dynamics. Implementing targeted intervention and sustaining efforts in disease control remains crucial in the face of evolving challenges posed by infectious diseases like malaria.

Keywords: *Malaria, COVID-19, Lockdown, Swat, KP*

INTRODUCTION

Malaria is regarded as a serious public health issue due to its high rates of morbidity and fatality. Malaria is preventable and curable, but it still has a terrible effect on people's health and means of sustenance around the world (Liu, *et al*., 2021). Many *Plasmodium* species are pathogenic to humans (Talapko *et al*., 2019). Five *Plasmodium* parasite species that cause malaria have been identified in different countries. These species include *P. vivax, P. falciparum, P. ovale, P. malaria,* and *P. knowlesi* (Farooq *et al*., 2020). Female Anopheles mosquitoes, commonly referred to as malarial vectors, bite humans and thus naturally transmit the parasite *Plasmodium*. The number of mosquito species is about 3,000 and just about 100 of them are considered to be human disease vectors (Rahman *et al*., 2017). Initial symptoms of malaria are similar to flu-like

symptoms and are nonspecific. Malaria appears with a wide range of symptoms and can proceed either rapidly or slowly (Trampuz *et al*., 2003).

Malaria has become prevalent in several countries, including Afghanistan, Yemen, Somalia, Sudan, and Pakistan. *P. falciparum* caused 14.7% of the malaria outbreak in Pakistan, while *P. vivax* was responsible for 81.3% of the cases, with 4% being a mixed infection. A few cases are caused by *P. falciparum* and many are caused by *P. vivax* (Farooq *et al*., 2020) In Pakistan, where the disease is widespread, 4 million confirmed cases are recorded annually. Pakistan is among the most afflicted countries in the world due to its high temperatures, high humidity, extensive irrigation system, farming regions, and monsoon rains. These factors make an ideal breeding environment for mosquitoes and encourage the life cycle of parasites (Hussain *et al*., 2021).

Over the past 20 years, significant progress has been made in reducing and/or eradicating malaria worldwide, with several worldwide projects having been initiated. From 2000 to 2019, the global incidence of malaria decreased from 363 to 225 cases per 1000 population (Hawadak *et al*., 2021). With effective malaria control programs (MCP), malaria cases have declined in several Asian and African nations, according to the most recent World Malaria Report. However, there has not been much of an improvement in Pakistan, India, or Bangladesh (Ghanchi *et al*., 2016). Malaria diagnosis is essential as soon as feasible in endemic areas like Pakistan in order to avoid further risks and fatal consequences (Mukry *et al*., 2017) as malaria is the leading cause of death and illness worldwide. Treatment for malaria must be commenced as soon as possible to lower morbidity and mortality because postponing treatment raises the death rate. Delaying treatment raises the risk of mortality or severe neurological consequences (Bronzan *et al*., 2008).

Materials and Methods

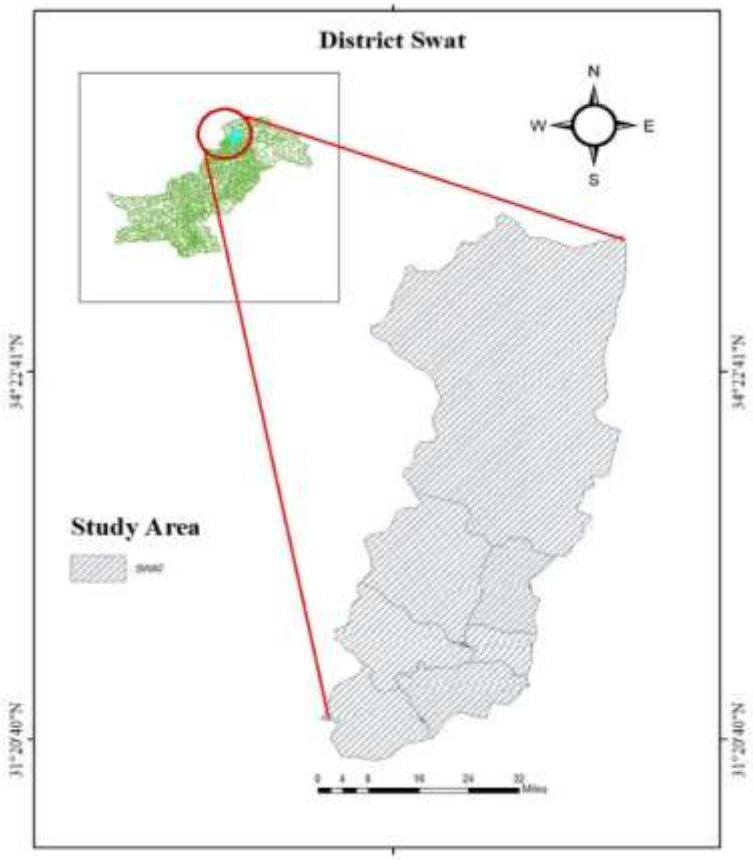
Study Area

The current study is carried out in Swat located in Khyber Pakhtunkhwa province on the North side. Swat district is situated from 34” 34’ to 35” 55’ north and 72” 08’ to 72” 50’ east. Swat is surrounded by Chitral and Ghizer Districts in the northern areas on the North Kohistan and Shangla Districts on the East whereas at the South by Malakand and Buner Districts. The main city of Swat is Mingora and the District headquarter is Saidu Sharif. There are seven Tehsil in the District i.e., Barikot, Babuzai, Charbagh, Bahrain, Kabal, Khwazakhela, and Matta. The area of Swat is around 5,337 square kilometers, and it is home to a wide range of animal and plant resources (Figure 1).

Study Design Data Collection

This cross-sectional study was conducted based on three years of data (2019, 2020, and 2021). Data was obtained from District Health Officer Malaria Laboratory Saidu Sharif, Saidu Central Hospital, Swat. Most malaria patients are admitted here; this is the government sector responsible for controlling dengue and malaria. The data included month-wise cases, malaria parasite species, patients' age and gender.

Figure 1: District Swat Map



Results

In the year 2019, the total number of cases of all diseases was 1480637 of which 51281 cases were screened for malaria among which 2650 (5.20%) cases were malaria positive (Table 1). The prevalence of malaria in 2019 was found at 5.20% and most of the positive cases were recorded in August (9.75%) followed by July (8.74%) (Figure 2).

In the year 2020, the total number of cases of all diseases was 837110 of which 48080 cases were screened for malaria. Among screened cases 476 (1.00%) cases were malaria positive (Table 1). The prevalence of malaria in 2020 was 1.00% and most of the positive cases were recorded in October (4.34%) followed by November (1.92%) (Figure 3).

In the year 2021, the total number of cases of all diseases was 889397 of which 48927 cases were screened for malaria. Among screened cases 543 (1.10%) cases were malaria positive (Table 1). The prevalence of malaria in 2021 was found 1.10% and most of the positive cases were recorded in September (2.72%) followed by October (2.32%) (Figure 4). Most of the cases were reported in 2019 (5.20%) as compared to 2020 (1.00%) and 2021 (1.10%) (Figure 5).

The total number of positive cases reported in three years was 3669 of which most of the cases were reported in summer 2512 (68.47%) followed by spring 474 (12.92%), autumn 439 (11.96%) and winter 244 (6.65%) (Table 2).

In the present study, most of the cases were infected in three years by *P. vivax* (97.57%) than *P. falciparum* (2.18%) and mixed parasite infection (0.19%) (Table 3).

In the overall three years, 3669 cases were malaria positive of which 300 (8.17%) cases aged less than five years (<5 Years) and 3369 (91.82%) cases aged greater than five years (>5 Years). Most of the cases were reported in the age category greater than five years (91.82%) (Table 4). Based on gender, most of the positive cases were reported among male (61.46%) than female (38.54%) (Table 5).

Table 1: Month-wise prevalence of malaria.

Year	Months	Total facility OPD	Malaria screened	Positive	Percentage
2019	**January**	142459	2152	15	0.69
	February	142031	2575	23	0.89
	March	163931	3369	53	1.57
	April	145321	3372	78	2.31
	May	111362	4492	210	4.67
	June	154400	6222	480	7.71
	July	181398	5786	477	8.74
	August	112912	5508	536	9.75
	September	45496	7480	560	7.52
	October	32729	2227	99	4.25
	November	111060	3850	74	1.92
	December	137538	4248	45	1.05
	Total	**1480637**	**51281**	**2650**	**5.20**
Year	**Months**	**Total facility OPD**	**Malaria screened**	**Positive**	**Percentage**
2020	**January**	104002	4207	25	0.59
	February	84939	5108	20	0.39
	March	57573	4049	17	0.41
	April	20275	1202	6	0.49
	May	33181	1621	9	0.55
	June	38517	2930	16	0.54
	July	61080	4278	39	0.91
	August	66689	6393	53	0.82
	September	89527	7937	74	0.93
	October	32729	2257	98	4.34
	November	111060	3850	74	1.92
	December	137538	4248	45	1.05
	Total	**837110**	**48080**	**476**	**1.00**
Year	**Months**	**Total facility OPD**	**Malaria screened**	**Positive**	**Percentage**
2021	**January**	83600	5111	30	0.58
	February	98233	5868	27	0.46
	March	77262	6591	28	0.42
	April	55490	5144	26	0.50
	May	57214	4728	47	0.99
	June	72922	5538	80	1.44
	July	79708	4109	64	1.55
	August	74869	3117	52	1.66
	September	78701	2976	81	2.72
	October	81937	2713	63	2.32
	November	66935	1570	31	1.97
	December	62526	1462	14	0.95
	Total	**889397**	**48927**	**543**	**1.10**

Figure 2: Month-wise prevalence of malaria int2019.

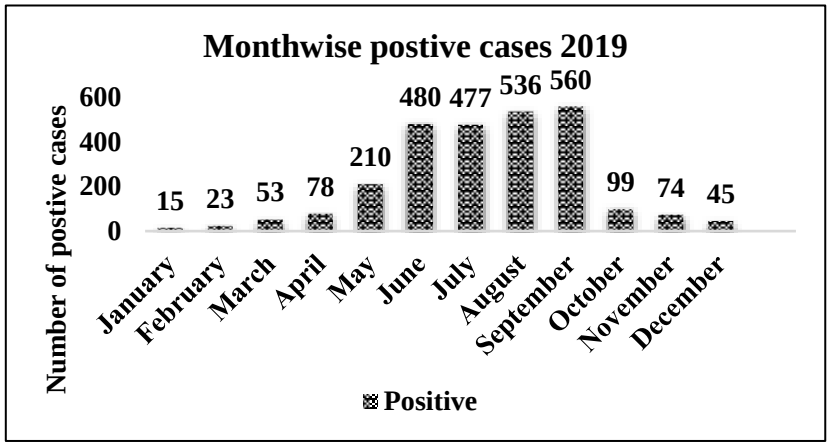


Figure 3: Month-wise prevalence of malaria int 2020.

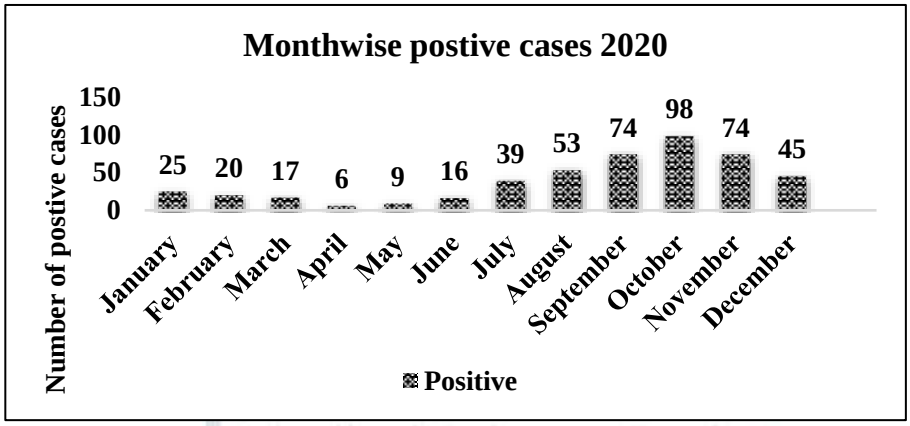


Figure 4: Month-wise prevalence of malaria int 2021.

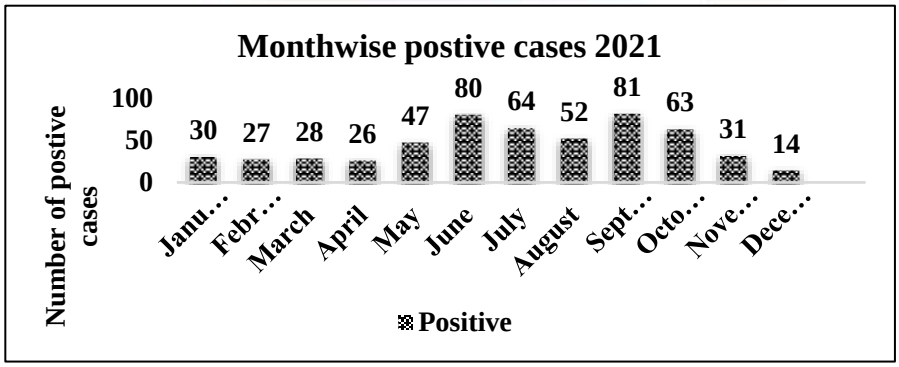


Table 2: Season-wise prevalence of malaria.

Months	Mar-May	Jun-Sep	Oct-Nov	Dec-Feb	Total
Seasons	**Spring**	**Summer**	**Autumn**	**Winter**	
2019	341	2053	173	83	**2650**
2020	32	182	172	90	**476**
2021	101	277	94	71	**543**
Grant Total	**474**	**2512**	**439**	**244**	**3669**
Percentage	**12.92%**	**68.47%**	**11.96%**	**6.65%**	**100%**

Table 3: Season-wise prevalence of malaria

Year	Malaria Positive	Gender	
		Male	Female
2019	2650	1502	1148
2020	476	337	139
2021	543	416	127
Total	**3669**	**2255**	**1414**
Percentage	**100%**	**61.46%**	**38.54%**

Table 4: Age-wise prevalence of malaria

Year	Malaria Positive	*Plasmodium* species		
		Plasmodium falciparum	*Plasmodium vivax*	Mix
2019	2650	67	2576	7
2020	476	5	469	0
2021	543	8	535	0
Total	**3669**	**80**	**3580**	**7**
Percentage	**100%**	**97.57%**	**2.18%**	**0.19%**

Table 5: Gender-wise prevalence of malaria.

Year	Malaria Positive	Age	
		< 5 Years	> 5 Years
2019	2650	269	2381
2020	476	10	466
2021	543	21	522
Total	**3669**	**300**	**3369**
Percentage	**100%**	**8.17%**	**91.82%**

Discussion

According to the surveillance, the prevalence rate in district Swat in 2019 was 5.2% followed by 2021 (1.10%), and 2020 (1.00%). The prevalence of the year 2019 in the district Swat was found similar to the Slutsker *et al*., (2016) report which states that at Queen Elizabeth Central Hospital in Malawi, the prevalence was 5·2%. However, the current study prevalence of 2019 was found to be less than the prevalence of Ullah *et al*., (2019) study conducted in the district Dir which is a neighboring district to Swat in which the prevalence rate was 12.2%. Variations in sample size and environmental conditions may account for the variation in prevalence rates. In the current study, the prevalence rate was 1.00% in the year 2020. In 2020, there was a pandemic of coronavirus disease (COVID-19) and the first case of coronavirus disease (COVID-19) was confirmed in Pakistan on February 26, 2020 (Daniyal *et al*., 2020). The virus gradually spreads to numerous areas across the country including Swat. The period from March 2020 to June 2020 was considered a lockdown period in district Swat (Ullah *et al*., 2022). The lockdown might be the reason for fewer cases in 2020 than in 2019 and 2021 because quarantine in the Swat district forced residents to stay at home and limited their access to public transportation and healthcare facilities. Similar findings were found in the study conducted by Torres *et al*., (2020) in which also most malaria cases were reported in 2019 (21925) than in 2020 (5161).

In the current study, the prevalence rate was 1.10% percent in district Swat in the year 2021. The different results were reported by Nizamani *et al*., (2006) whose study contains a 2.67% prevalence rate in 2004 and a 2.12% prevalence rate in 2005. Different study designs, different sample sizes, different study durations, and different meteorological conditions can all be blamed for the

variations in malaria prevalence rates. It is also possible that, in comparison to prior years, the environmental conditions in 2021 were less favorable for mosquito breeding and the spread of malaria. It is imperative to take into account additional factors that may have led to the further decline in cases in 2021 following the Lockdown of 2020.

In Pakistan, *P. vivax* contributed 81.3% to the malaria outbreak followed by *P. falciparum at* 14.7% and 4% is a mixed infection. Many cases are caused by *P. vivax* and few cases are caused by *P. falciparum* (Farooq *et al*., 2020). In the current study, in the previous three years, malaria patients were more affected by *P. vivax* than *P. falciparum.* The parasite *P. vivax* caused 97.57% of infections, *P. falciparum* caused 2.18% of infections and 0.19% of infections were caused by both. The same study was conducted by Khan *et al*., (2019) in which the most malaria infection-causing parasite was *P. vivax* (98.6%) and the least malaria infection-causing parasite was *P. falciparum*. The result of the current study was also the same as the result of (Qureshi *et al*., 2019) in which most of the cases were reported by *P. vivax* (66.7%) and fewer cases by *P. falciparum* (23.7%) and mixed infection by these two species (9.6%). The reason behind the low prevalence of *P. falciparum* could be that the parasite is not endemic in district Swat and might be spread by patients who might have traveled outside Swat and brought the parasite *P. falciparum* with them into Swat.

Based on the seasons, most of the cases in three years were reported in summer (68.47%) followed by spring (12.92%), autumn (11.96%), and winter (6.65%) respectively. Except in 2020 spring, less parasitemia was recorded as compared to spring of the year 2019 and 2021. The low parasitemia may be due to coronavirus disease (COVID-19) because the period from March 2020 to June 2020 was considered a lockdown period in district Swat (Ullah *et al*., 2022) and the people might not have visited healthcare institutions to get diagnosed. The current study was found similar to the study of Qureshi *et al*., (2019**)** in which also a high number of malaria cases were recorded in summer. The reason might be the rain during summer because the country's extensive irrigation system, agricultural methods, and monsoon rains all contribute to the development and spread of malaria vectors.

The cases of malaria were fewer in patients aged less than five years (8.17%) than in those aged greater than five years (91.82%). The same results were approximately conducted by Ghanchi *et al*., (2011), in which also lee number of cases (0.14%) were reported in the age category less than or equal to five years while more cases (85.65%) were reported in the above five years age. In the study of Lee *et al*., (2010), malaria infection was high among patients whose age was less than five years while the infection was less common among patients whose age was over five years. The low prevalence among less than five years of patients in the current study might be because of parental care in the area.

In this study, in overall three years, most of malaria cases were recorded among males (61.46%) than females (38.54%). According to the Nas *et al*., (2017) Study, there are 194 (52.4%) more female patients than male patients 176 (47.6%). The outcome was different from the current investigation. Males were more likely than females to have malaria, according to studies (Ayele *et al*., 2012), which is consistent with the results of the present study. Males may be more likely to experience this increased frequency because they are more likely to work outside in public settings without covering their bodies. On the other hand, because of cultural norms, females are restricted to their homes and typically cover thoroughly so they are not exposed to bites from mosquitoes.

Conclusion

The study shows that the prevalence of malaria fluctuated over three years in the Swat district, with a notable decline during the COVID-19 lockdown in 2020. Summer had the highest number of malaria cases. Males were the individuals who reported the most cases, maybe because of work exposure. Fewer cases were reported for patients under the age of five. The most common parasite species was *Plasmodium vivax*, which called for focused control measures. The importance of continuous surveillance and control efforts in the region to lessen the disease's impact and stop further outbreaks in the area.

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