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Epidemiological Characteristics of Malaria in Kohat Division and Effect of Current Eradication Program

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Abstract

Objective: This retrospective study's purpose was to provide insight into the distribution and trend of malaria cases in the Kohat District of KPK, Pakistan, from 2017 to 2021. The analysis of the sociodemographic traits, annual trends, species distribution, and seasonal fluctuations of malaria cases was the main goal of the study.

Methodology: The DHQ Divisional Headquarter Hospital in Kohat, which is overseen by the KPK, Peshawar malaria control program, provided the laboratory logbook from which the data was taken. Every suspected case of malaria that provided blood samples for microscopy was recorded in the study's logbook. We retrieved and analyzed data on the participant's demographics, pregnant status, diagnostic month and year, and parasite species found.

Results: 10,958 cases of malaria were verified out of 17,832 blood films that were analyzed during the study period. Males (53.2%) and those over the age of five (9,036 cases) accounted for the majority of cases. P. vivax accounted for 88% of the total species, with P. falciparum (10%) and mixed infections (2%), following in order. The majority of those affected were over the age of 15, and males were more likely than females to become infected. Cases of malaria were reported all year round, with summer and fall seeing the greatest transmission.

Conclusion: This study offers important new information about the five-year malaria trend in the Kohat District. The results emphasize the necessity of focused measures to alleviate the greater incidence of malaria in boys older than 15 years. The report also emphasizes how crucial monitoring and surveillance systems are to directing evidence-based treatments and maintaining advancements in the fight against malaria. Subsequent investigations ought to concentrate on executing specific measures and assessing their efficacy, and looking into the effects of climate change on regional transmission of malaria as well.

Keywords: Hypothyroidism, Hyperthyroidism, Thyroid Diseases, Apoptosis, Endocrine Gland, Metabolism

Introduction

Malaria is a likely fatal parasite disease generated by Plasmodium species and spread by the bite of infected Anopheles mosquitoes. Malaria is still a most important public health problem despite international attempts to control and eradicate the illness, particularly in developing countries like Pakistan.[1] The prevalence and distribution of malaria parasites were examined in the general population of District Dir Lower, Khyber Pakhtunkhwa, Pakistan, according to studies conducted by Shah et al, and Khattak et al.[2,3] According to the study, there is a significant prevalence of malaria in the area, as evidenced by the widespread presence of malaria parasites in the population. This study emphasizes the necessity of implementing efficient management strategies to lower the local malaria incidence.

Ullah et al used the PCR technique to ascertain the Plasmodium vivax prevalence among Afghan refugees in the Ghamkol Camp District Kohat, Pakistan using the PCR method.[4]

Contributions:
M.A, M.A.J, M.Y, RT - Conception of study - Experimentation/Study Conduction
M.A, M.A.J, S.U - Analysis/Interpretation/Discussion
M.Y, RT, S.U - Manuscript Writing
M.Y, RT - Critical Review

All authors approved the final version to be published & agreed to be accountable for all aspects of the work.

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The results showed a high prevalence of Plasmodium vivax in the population, which suggested that better control methods were required to lower the local malaria incidence.

Another study by Zareen et al, shows that the risk of contracting malaria is higher for Afghan refugees residing in Pakistan.[5] In a highly endemic region of Khyber Pakhtunkhwa, Pakistan, studies by Khan et al, and Jahan et al, examined the burden of malaria infection among newborns. The findings demonstrated that a sizable percentage of newborns had malaria, emphasizing the necessity of efficient management strategies to lower the disease's occurrence in this susceptible group.[6,7] The 2019 edition of the Pakistan Malaria Annual Report contains comprehensive information on the epidemiology and prevention of malaria in Pakistan.[8] It contains information on the prevalence of malaria, the distribution of cases, and the efficiency of the existing defense strategies. The study identifies areas that require additional action and offers insightful information about the current efforts to eradicate malaria in Pakistan.[8] An overview of the biology and pathophysiology of malaria is given by Miller et al, with an emphasis on novel therapeutic strategies. The authors emphasize that to create more potent treatments, a thorough understanding of the molecular pathways underlying malaria infection and illness development is necessary. For researchers and medical professionals involved in the prevention and treatment of malaria, this paper is an invaluable tool.[9] A thorough assessment of the global malaria situation, including data on trends, incidence and death, and advancements made toward the eradication of malaria, may be found in the 2018 World Malaria Report. The study offers suggestions for further action and outlines the potential and difficulties in the fight against malaria. In their efforts to eradicate malaria worldwide, policymakers, medical professionals, and researchers can use this study as a valuable resource.[10] In Pakistan's Bannu district, Khatoon et al, investigated the genetic composition of Plasmodium falciparum and Plasmodium vivax. Their discovery that the two parasite species have distinct genetic structures may have an impact on how malaria prevention and control strategies are developed and carried out. These studies contribute to a better understanding of the malaria epidemiology in Pakistan and may influence future attempts to eradicate and control malaria in the area.[11] The necessity of early detection and timely treatment of malaria cases is emphasized by the NMCP. Rapid diagnostic tests (RDTs) or microscopy are used to examine suspected cases, and those that are found to be positive are treated right away with the proper antimalarial medications. Additionally, the initiative trains medical professionals to enhance the standard of diagnosing and treating malaria.[12] This study aims to evaluate the efficacy of the ongoing malaria eradication campaign as well as explore the epidemiological features of the disease in the Pakistani district of Kohat. The research will use information from previous studies in addition to data from the 2019 Pakistan Malaria Annual Report, which was released by the Directorate of Malaria Control in Islamabad. The World Health Organization's 2018 World Malaria Report will also be consulted for this study. The results of this investigation will furnish significant insights into the present condition of malaria in Kohat, Pakistan, and aid in the formulation of efficacious approaches for its management and eradication.

Materials And Methods

The study was conducted at the DHQ Divisional Headquarter Hospital in Kohat, which is overseen by the KPK, Peshawar malaria control program. The typical temperature ranges from 10°C to 40°C, with four distinct seasons. Winter, which is cold and lasts from December to February; spring, which is hot and lasts from March to May; summer, which is hot and lasts from June to August; and autumn, which lasts from September to November.[3]

To investigate the prevalence, distribution, and trend of malaria across different demographic parameters like sex, age, pregnancy, and season, a study based on health facilities was conducted. The study was conducted over five years at DHQ Hospital Kohat as part of KPK Peshawar's malaria control effort. People with probable malaria who had made blood samples available for blood film microscopy were included in the study. The laboratory logbook, which was run under KPK Peshawar's malaria control program, had the data from DHO Kohat.

Before extracting data from the laboratory logbook—which was kept up to date under a malaria control program- a Microsoft Excel data extraction sheet was made. The purpose of this form was to gather demographic data from participants, including age, gender, pregnancy status, and the month and year of their diagnosis. The relevant variables were then copied over to the specified data extraction spreadsheet from the lab's logbook. The parameters gathered from the study included the demographics of the clients (age and sex), in addition to clinical criteria such as the clients' pregnancy status, date of diagnosis, diagnostic techniques used, investigation results, and the particular parasite species found. The training of the data collectors included instruction on the research objectives, interest variables, and data extraction technology to guarantee the consistency and integrity of the data. In addition, the study team members were responsible for supervising each stage of the data extraction and input procedures.

Participants in the study were individuals who submitted complete logbook data, including date of diagnosis, sex, year, and age; those who only submitted partial data were not included.

Operational Definitions

Suspected Cases:

A patient with a suspicion of malaria who indicated interest in having a blood test performed.

Confirmed Cases:
Individuals who had a blood film malaria diagnosis.
Slide Positivity Rate:
The percentage of slides that tested positive for malaria out of all the slides was noted.
The data underwent thorough coding and validation utilizing the epi data program before statistical analysis. After that, the data was moved once more to SPSS for statistical analysis. Descriptive statistics were employed to illustrate the distribution of malaria transmission in connection to demographic variables such as gender, age, season, and detected parasite species. The Pearson's test was utilized to evaluate the correlation between the independent and dependent variables. Statistical significance was achieved at a significance level of less than 0.05. Tabular forms, graphical representations, and textual illustrations were used to display the results.
Before data collection, the Kohat Institute of medical sciences ethical committee granted ethical approval for the study (No: Dir/KMU-EB/DR/72-364), which was conducted by the Declaration of Helsinki. The need to get patients' informed consent was dropped because the study was based on anonymous secondary data. The health center's data was stripped of personal names to maintain anonymity, and instead, unique identification numbers were used for each participant.

Results

171,832 samples were tested for blood films at DHQ hospital Kohat between 2017–16 and 2019–21. Out of these tested samples, 5,904 (53.2%) of the probable cases were male, while the remaining cases were female. Nine thousand,036 potential malaria patients were older than five during the study period, whereas 1,922 (17.1%) were younger than five. Within the study region, just P. falciparum and P. vivax species were identified, with P. falciparum accounting for 1130 (10%) and P. vivax accounting for 9645 (88%), whereas only 183 (2%) of the mixed infections were responsible for the overall prevalence. 110 pregnant females were also affected between 2017 and 2021 (Table 1; Figure 1)

Table 1: Sociodemographic Characteristics of the Study Participants

Sociodemographic Characteristic	Number of Participants	Percentage
Total Participants	171,832	100
Gender		
- Male	5,904	(53.2%)
- Female	5,188	(46.8%)
Age Group		
- Under 5 years	1,922	(17.1%)
- 5 years and above	9,036	(82.9%)
Malaria Species		
- P. falciparum	1,130	(10%)
- P. vivax	9,645	(88%)
- Mixed Infection	183	(2%)
Pregnant Females	110	100%

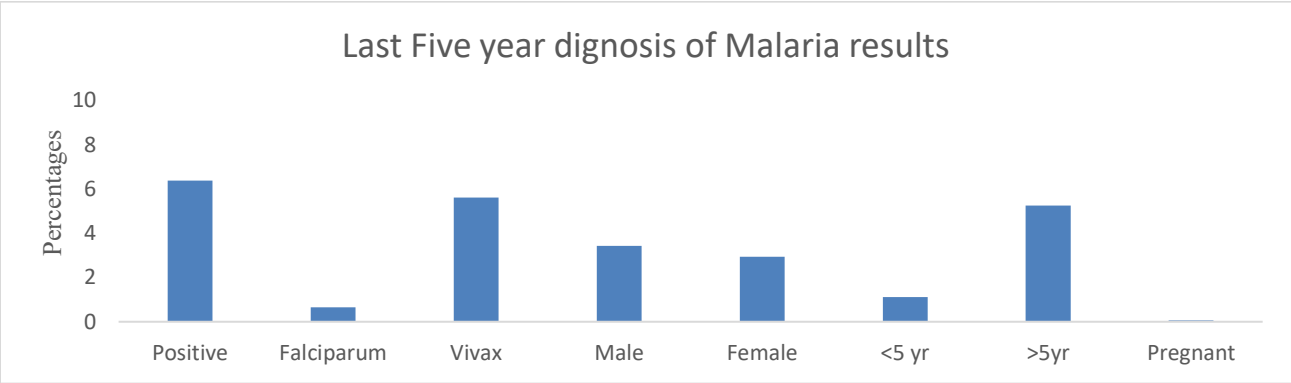

Figure 1: Percentage Sociodemographic Characteristics of the Study Participants

Total Malaria Cases, Annual Trends

After screening 171832 patients with microscopy and RTD, 10958 of them had a positive diagnosis of malaria. On average, 34366.4 cases of malaria were reported annually. 2019–20 and 2018–19 had the highest percentage of malaria cases, whereas 2021 had the lowest percentage of infections. The percentage of confirmed malaria cases grew in 2017 and reduced in 2018, then decreased again in 2019 and 2020, then decreased again in 2021, indicating that the cases were not consistent across these years (Table 2) (Fig. 2).

Table 2: Annual Trends in Total Malaria Cases

Year	Screened	Positive
2017	29750	4536
2018	39222	3309
2019	36733	1430
2020	44334	1361
2021	21793	322

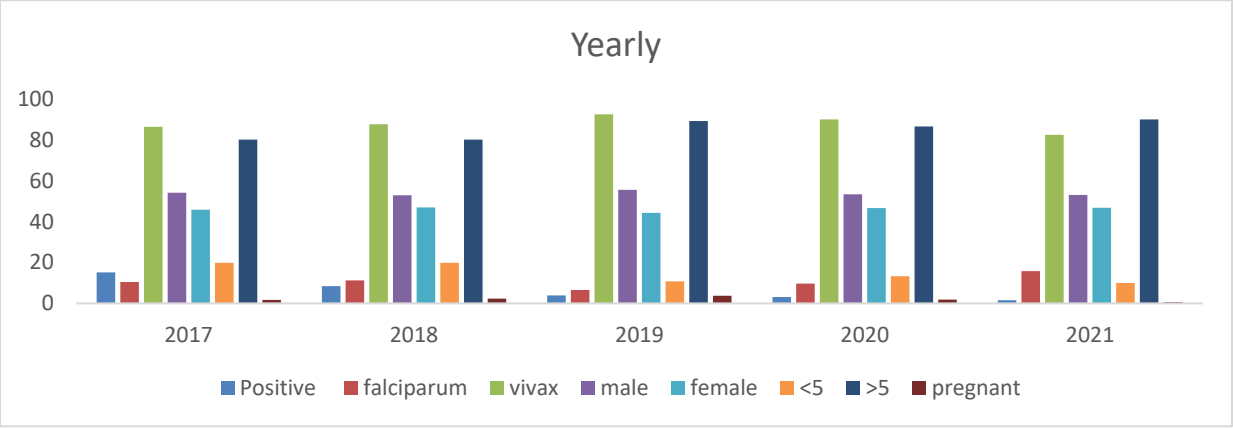

Figure 2: Annual trends in percentage of study participants.

Distribution of Plasmodium species

P. falciparum species was found in the research area, accounting for 1130 (10%) of the total frequency. P. vivax followed with 9645 (88%), and mixed infection with just 183 (2%). In this retrospective research, P. vivax was approximately nine times more prevalent than P. falciparum. There has been little variation in the prevalence of P. vivax over time, ranging from 88% to 2.4% in 2017–2021. On the other hand, the prevalence of P. falciparum dropped somewhat from 33% to 8% during 2018 and 2019. The percentage of mixed infections dropped somewhat between 2017 and 2021, from 73% to 2% (Table 3).

Table 3: Shows the distribution of Plasmodium species

Plasmodium Species	Prevalence
P. falciparum	1,130 (10%)
P. vivax	9,645 (88%)
Mixed Infection	183 (2%)

Cases of Malaria by Age and Gender

In general, malaria was more common in men than in women. There were 10958 confirmed cases of malaria; however, only 5054 cases included females and 5904 cases involved males.9036 patients in this study had malaria parasite infection; however, the infection rate was lowest in children under five.

Seasonal Distribution of Malaria

Even though malaria cases vary throughout the year, reports of the condition were made each month. The highest and most consistent rainfall occurred in June and August, with the lowest amounts occurring in May and the highest in November, October, and September. The highest rates of malaria transmission occurred during these months. There were reports of malaria cases all year round, with summer (June to August) and fall (September to November) seeing the highest number of cases, and winter (December to February) seeing the lowest number of cases.

Trend in Malaria and Sociodemographic Variables

Among the last five years of malaria prevalence, males exhibited a significantly higher likelihood of infection compared to females (adjusted odds ratio [AOR] = 1.17416, 95% confidence interval (13) = 1.130, 1.219, P < 0.000). In the year 2018, males were found to be the most affected gender (AOR = 1.132967, 95% CI = 1.07, 1.19, P < 0.000). The prevalence of P. vivax was observed to be higher than that of P. falciparum over the last five years (AOR = 0.11131, 95% CI = 0.104623, 0.118435, P <0.0014). Specifically, in 2017, a majority of reported cases involved P. vivax within the five years (AOR = 0.107703, 95% CI = 0.097, 0.118, P < 0.000). Individuals above the age of five exhibited a higher susceptibility to infection compared to those below the age of five (AOR = 0.203799, 95% CI = 0.193918, 0.214184, P <0.0010). In 2017, a greater proportion of affected individuals over the age of five were reported within the five years (AOR = 0.223724, 95% CI = 0.207, 0.241, P < 0.0000). Total pregnant females affected were 110 in five years, and most of the cases were reported in 2018, that is 37 (Table 4).

Table 4: Association of Malaria Trend with Sociodemographic Factors

Sociodemographic Factor	AOR	95% CI	p-value
Gender (Last 5 years)	1.17416	1.130, 1.219	<0.000
Gender (2018)	1.132967	1.07, 1.19	<0.000
Malaria Species			
- P. vivax (Last 5 years)	0.11131	0.104623, 0.118435	<0.0014
- P. vivax (2017)	0.107703	0.097, 0.118	<0.000
Age			
- Age >5 years (Last 5 years)	0.203799	0.193918, 0.214184	<0.0010
- Age >5 years (2017)	0.223724	0.207, 0.241	<0.000
Pregnant Females (5 years)	Total	-	-
- Total cases	110	-	-
- Cases in 2018	37	-	-

Discussion

With high morbidity and mortality, malaria is a serious worldwide health concern, especially in tropical and subtropical climates. It's an infectious sickness spread by mosquitoes that's brought on by the Plasmodium parasite. Malaria is a multifaceted illness that is impacted by several variables, including socioeconomic status, human behavior, climate, and vector ecology. Public health systems are severely burdened by it, particularly in poor nations. Malaria is still a serious health issue in Pakistan, where it is highly contagious in many areas. In 2020, Pakistan was responsible for almost 3% of all malaria cases worldwide, according to the World Health Organization. Malaria continues to be a major global public health concern, especially in areas like Pakistan where transmission rates are high. The purpose of this study was to look into the distribution, trend, and prevalence of malaria over five years in the Kohat District of KPK, Pakistan. The results can advance our knowledge of the disease overall and offer insightful information on the epidemiology of malaria in the area. The study's conclusions showed that the number of instances of malaria varied during the five years. The years with the largest percentage of malaria cases were 2017–18, 2018–19, and 2021, which had the lowest percentage of cases. These results are consistent with a retrospective research carried out in Mardan, Pakistan, which revealed a variable pattern in the prevalence of malaria.[14,15] In a similar vein, research carried out in Nigeria's Ondo State revealed fluctuations in the number of malaria cases over time.[16,17] These results highlight the dynamic nature of malaria transmission and the necessity of ongoing surveillance and control measures execution to effectively fight the illness. In terms of species distribution, this study discovered that P. vivax accounted for a substantially higher number of cases, whereas P. falciparum was also present in the studied area. This is in line with research from other parts of Pakistan, like Balochistan and Khyber Pakhtunkhwa, which also found that P. vivax was more common than P. falciparum.[18,19] Global reports of P. vivax predominance have been made in several malaria-endemic regions, such as Ethiopia, India, and Nepal.[20-22] Given that different Plasmodium species require distinct treatments and treatment modalities, the varying prevalence of these species may have an impact on malaria control measures. This study demonstrated that there are gender and age differences in the malaria load, with

males being more impacted than females and those over 15 having the highest malaria burden. Other studies carried out in Pakistan have also shown similar gender differences, including one in Balochistan that found that males were more likely than females to get malaria.[19,23] In contrast, research from other nations, such as Zimbabwe and Uganda, revealed that women were more likely than males to contract malaria.[24,25] These differences in gender disparities could be caused by things like behavior habits, access to healthcare, and place of employment. This study's seasonal distribution of malaria cases showed that the summer and fall months, when there is more rainfall, have greater transmission rates. Studies carried out in other parts of Pakistan, including the Punjab research, have found similar seasonal trends.[26] Studies undertaken abroad, particularly in Ethiopia and Malaysia, have also identified seasonal fluctuations in the spread of malaria.[27,28] These results highlight the need of putting seasonal malaria control measures and targeted interventions into place during times when the risk of malaria transmission is higher. The results of this study can be compared with those of other comparable investigations carried out in Pakistan and throughout the world to get important insights into the regional variations and similarities in the epidemiology of malaria. Recognizing the distinctive qualities and constraints of any study—such as differences in sample size, study design, and geographic location—is crucial. However, the overall understanding of malaria epidemiology is strengthened by the consistent data about the seasonal fluctuations, gender disparities, P. vivax predominance, and the fluctuating trend of malaria cases. Implementing comprehensive and context-specific control measures is necessary to effectively address the malaria burden. The findings of this study reveal fluctuations in malaria incidence in Kohat over the study period, with a notable decline in cases in 2020 and 2021. This reduction may be linked to the ongoing malaria control and eradication efforts implemented in the region. The National Malaria Control Program (NMCP), in collaboration with the KPK malaria control initiative, has focused on vector control measures such as indoor residual spraying (IRS) and the distribution of insecticide-treated bed nets (ITNs). Additionally, increased access to rapid diagnostic tests (RDTs) and the widespread availability of artemisinin-based combination therapies (ACTs) have contributed to improved case management and early treatment. Despite these efforts, the persistent presence of malaria cases, particularly in high-risk groups such as males over 15 years, underscores the need for continued surveillance, community awareness campaigns, and targeted interventions. Further studies assessing the direct impact of these eradication strategies on malaria transmission trends are warranted to refine and strengthen control measures in the region. These could include seasonal malaria control measures during times of higher transmission and focused treatments for high-risk groups, such as men and those over the age of fifteen. Furthermore, key elements of malaria control initiatives include bolstering the healthcare system, expanding access to diagnosis and treatment, and encouraging community involvement and awareness.

Conclusions

The main conclusions of this retrospective study include the distribution, prevalence, and trend of malaria in the Kohat District of KPK, Pakistan. The results highlight P. vivax dominance, gender and age disparities, seasonal variations in malaria cases, and the dynamic nature of malaria transmission. The study highlights the burden associated with the greater prevalence of malaria among men and those over 15, as well as the necessity for targeted interventions. The importance of using seasonal malaria management techniques during periods of increased transmission is also emphasized by the study. These results contribute to our understanding of the malaria epidemiology in the area and can guide the development of effective interventions for malaria prevention and control.

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