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Research Article

A Cross-sectional Study on Burden of Human Malaria Infection at Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences, Gambat, Pakistan

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Abstract

Malaria is a major public health problem caused by *Plasmodium* species and is spread naturally through the bite of the female Anopheles mosquito. This study was conducted at Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences, Gambat, Pakistan to determine the prevalence of malaria with respect to age, sex, and month-wise distribution. Primary and secondary data were collected during August to September 2023 and from January 2022 to July 2023, respectively. The primary dataset included 200 suspected malaria cases, while secondary data comprised records of 970 individuals, later they were sorted out for positive and negative cases. Diagnosis of malaria was performed using microscopic examination and rapid diagnostic tests**.** The results obtained showed that (40%) patients were positive for the malarial parasite with 40% prevalence rate. The study population revealed that male (52%) had a higher prevalence of malarial infection as compared to females (28%). The *Plasmodium vivax* was found 36.5% in the positive cases, while *Plasmodium falciparum* was 3.5%. The *P. vivax* in females was 89.2% and *P. falciparum* was 10.7%. According to results of primary data, distribution of malaria cases was found with high percentage of 44% in August compared to September with 36%. In different age groups, the age group from 1-10 years was found to be most prevalent group with the cases of 71%, the 5.3 ± 2.01years was the average age. In the age group of 31 and above years the lowest prevalence of malaria, 32.43% was found with 34.91 ± 2.6 years of average age. The secondary data showed that female population 45.45% was more prevalent to malaria in November 2022 and the male population was more prevalent in May 2022 with 46.87%. While in 2023 the highest cases with 19.04% of female population were found in the month of March and in January maximum cases of male population were observed with 28.20%. The current work concludes that male population was more infected 52% as compared to female population 28%. The 1-10 year age group was the most prevalent, accounting for 71%. In present study the *P. vivax* was found to be dominant species compared to *P. falciparum*.

Keywords: Malaria, Parasite, *P. vivax*, *P. falciparum*, Gambat, Pakistan

1. Introduction

Vector-borne protozoan disease malaria occurs due to six *Plasmodium* spp. and the female Anopheles mosquito spreads this disease, leading to significant medical and economic impacts (Cox 2010; Snow et al. 2005; WHO 2014; WHO 2017). Two species, including *Plasmodium vivax* and; *Plasmodium falciparum*, are known to infect people in Pakistan and are the foremost common and broadly conveyed parasites (Qureshi et al. 2019; Karim et al. 2021). Fever, headaches, and chills are

Table 1: Total number of malarial suspects with percentage of positive and negative male and female cases at Pir Abdul Qadir Shah Jeelaani Institute of Medical Sciences, Gambat, Sindh, Pakistan.

Gender	Number	Positive percentage	Negative percentage
Male	100	52%	48%
Female	100	28%	72%
Total	200	40%	60%

the most typical early signs of malaria. The transmission of malaria is primarily done by an infectious mosquito, specifically the female Anopheles mosquito. After being infected by an infectious mosquito, signs usually appear after 10 to 15 days. Some people, particularly those who have suffered from malaria, may only experience average symptoms. Early testing is crucial since certain symptoms of malaria are non- specific. Clinical signs and symptoms emerge during the parasite's asexual stage, primarily during the erythrocytic cycle, when the parasite replicates in red blood cells. The blood parasite's count and clinical manifestations are inversely correlated (Adak et al. 2005).

The National Strategic Plan for Malaria Elimination (NSP-ME) in Pakistan 2021-2035 has been developed through technical support of WHO and Financial support of The Global Fund (TGF). An extensive consultative process with all provinces. However, concurring with the malaria Report for 2019, in 87 countries and regions around fifty percent of the world's population lives at risk of malaria transmission (WHO 2019). In 2020, it was assessed that malaria affected 241 million medical events and brought about around 627,000 deaths (WHO 2021). Agreeing to the World Health Organization (WHO), Pakistan is one of the seven nations within the eastern Mediterranean area that reports for 98% of the whole endemicity of malaria within the area (Malaria Annual Report 2019).

Approximately 217 million people in Pakistan are at moderate risk of malaria, and 63 million people are at high risk.

Around 0.47 million malaria cases and approximately 800 malaria-related death cases have been reported in 2020 (Hashem et al. 2020).

Besides this, as per WHO's Global malaria report 2023, Pakistan stands out with the largest case number increase from 2021 to 2022 (2.1 million a fivefold rise), primarily due to devastating floods at district Khairpur including Gambat was amongst the most flood affected districts. This has possibly increased the burden of malaria in district Khairpur Sindh. This is because present study aimed to determine the prevalence and demographic distribution of malaria infection in patients attending Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences, Gambat Pakistan. Present study will provide the baseline information for the management of the problem in the region.

2. Materials and Methods

The Gambat, Pakistan was selected for this transverse study to know the malarial burden in the area. The collection of data was done from Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences, Gambat. The primary data were collected prospectively, and the secondary data were obtained from hospital records. The primary data was collected from August to September 2023 on a daily basis and secondary data of nineteen months was collected from January 2022 to July 2023 (Yasinzai and Kakarsulemankhel 2008; Khan et al. 2024). In the primary data total of 200 suspected patients with symptoms of shivering and fever were enrolled. The patients were fractionated into different age groups: 1 to 10 years, 11 to 20 years, 21 to 30 years, and 31 and above years. The data was analyzed month-wise, age-wise, and sex-wise using the descriptive statistics in the computer program excel.

While in the secondary data, the all records (already diagnosed positive or negative) of 970 persons were taken; later, they were sorted out

Table 2: Gender wise percentage of *Plasmodium vivax* and *falciparum* from August to September 2023 at Pir Abdul Qadir Shah Jeelaani Institute of Medical Sciences, Gambat, Sindh, Pakistan.

Gender	Slides examined	+ve cases	*P. vivax*	*P. falciparum*
Male	100	52	48 (92.3%)	04 (7.6%)
Female	100	28	25 (89.3%)	03 (10.7%)

for positive and negative cases. In primary data, the blood samples were analyzed using the both methods, including microscopy with thick and thin blood smudge and rapid diagnostic test. For microscopic examinations, a drop of the blood was kept over the slide and spread out for blood smear to identify the malarial parasites. Giemsa stain was applied to the specimen. A minimum of two thick and thin smears was prepared for each patient. A little drop of blood was placed on a slide's corner for a thin smear and spread at a 45-degree angle using a second spreader slide and then lowered at a 30-degree angle and gently pressed to the left. For a thick smear, a large drop of blood was placed on a clean glass slide of 1-2 cm square (Chu et al. 2019).

For rapid diagnostic test kit 0.001cc of blood was taken from the patient and poured into a circular well. Afterwards, four drops of buffer solution were added. The appearance of two lines after 15 minutes of test analyzing was considered positive, whereas if only a single control line showed, it was considered a negative result. When all three lines appear, it indicates a mixed infection involving both *P. vivax* and *P. falciparum*. The *Plasmodium* spp. was identified using microscopic examination of a blood smear by their morphology. If the color of *Plasmodium* spp. is pink, oval shaped structure is *P. vivax*, whereas *P. falciparum* exhibits a crescent-shaped and dark purple color.

2.1 Inclusion and Exclusion criteria

All the suspects having body temperature > 37.50 °C along with symptoms like body aches, chills, nausea and vomiting were included in the study, while all other suspects with other complications such as diabetes, hepatitis and those women with pregnancy were excluded from the study, because the patients with greater complications may have low immunity and remain at risk of diseases.

3. Results

3.1 Prevalence of malaria based on primary data from August to September 202

In present study a total of 200 malarial suspected patients (100 male and 100 female) were enrolled. Among the total male cases 52% were positive cases and 48% cases were negative male, similarly among total female cases 28% were positive female and 72% were negative female **(Table 1)**. However, in primary data the prevalence rate was calculated to be 40%.

Obtained results in present study showed infection of malaria was 52% in male population while in female population 28% infection of malaria was observed, which determined that male is more infected compared to females. In male, *P. vivax* was found 92.3% and *P. falciparum* 7.6%. While, in females (89.3%) *P. vivax* was observed and (10.7%) was *P. falciparum* **(Table 2)**.

3.2 Prevalence of malaria from January 2022 to December 2022

The present study was conducted to determine the prevalence of malaria at Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences from January 2022 to December 2022. In the present research work a total of 616 patients were enrolled. The results showed the maximum prevalence was found in October, with a total of 258 cases in females, amongst them 92% were with *P. vivax* and 7.6% *P. falciparum*. Whereas in males, the 95.2% *P. vivax* and 4.70% *P. falciparum*. The minimum prevalence was found in the month of May, with 0% *P. vivax* and 0% *P. falciparum* in females.

While in males' minimum prevalence was observed in the months of June to August, with no positive cases **(Table 3)**. However, prevalence

Table 3: Percentage of month-wise prevalence of malaria in the general population during the year 2022 at Pir Abdul Qadir Shah Jeelani Institute of Medical Science, Gambat, Sindh, Pakistan.

Months	Total recorded persons	+ve Females		+ve Males	
		P. vivax	*P. falciparum*	*P. vivax*	*P. falciparum*
January	57	2(100%)	0(0%)	1(100%)	0(0%)
February	22	3(75%)	1(25%)	4(100%)	0(0%)
March	32	1(100%)	0(0%)	3(75%)	1(25%)
April	31	2(100%)	0(0%)	1(100%)	0(0%)
May	32	0(0%)	0(0%)	14(93.3%)	1(6.66%)
June	30	1(0%)	0(0%)	0(0%)	0(0%)
July	24	3(25%)	1(25%)	0(0%)	0(0%)
August	24	2(100%)	0(0%)	0(0%)	0(0%)
September	60	12(92%)	1(7.6%)	14(100%)	0(0%)
October	258	24(92%)	2(7.6%)	40(95.2%)	2(4.70%)
November	11	3(60%)	2(40%)	2(100%)	0(0%)
December	35	3(100%)	0(0%)	5(100%)	0(0%)

was calculated in female 10.2% while in males 14.2%.

3.3 Prevalence of malaria from January 2023 to July 2023

The secondary data was collected from January 2023 to July 2023 based on 354 suspected male and female populations. Out of them, 57 positive female cases were observed during the months of January to July. In female population maximum prevalence of *P. vivax* was observed in the month of July with 100% and maximum prevalence 16% of *P. falciparum* was observed in the months of March and June. Whereas 72 positive male cases were observed in which maximum prevalence of *P. vivax* was observed in the month of March with 86% and 13% *P. falciparum*. While in female minimum percentage of *P. vivax* was observed in the month of May with 66% and *P. falciparum* in the months of January and July, and in male minimum percentage of *P. vivax* was found in the month of January with 54% and *P. falciparum* in the months of May and July with 0% (**Table 4)**. However, prevalence was calculated in females 16.3% while in males 20%. While total prevalence for 2022 and 2023 combined was calculated as 15.5%.

3.4 Prevalence of malaria in different age groups

Current research was based on different age groups, including 1-10 years, 11-20 years, 21-25 years and above 30 years of age. In present study, it was observed that in 1-10 years of age group 23 cases were positive females, amongst the, 91.6% have *P. vivax* and 8.6% have *P. falciparum*. Whereas 35 cases were observed positive males, out of them, *P. vivax* was in 94.2% and *P. falciparum* was 5.7%. In 11-20 years, 3 cases were positive females, with 66.6 % *P. vivax*, 33.3% with *P. falciparum*. While 9 cases were positive male, 77.7 % were with *P. vivax*, 22.2% were with *P. falciparum*. In 21-30 years, 1 case were positive female, in which 100% were with *P. vivax*, 0% were with *P. falciparum*. whereas 4 cases were positive male, 100% *P. vivax*, 0% were *P. falciparum*. In 31 and above years, 1 case was a positive female, 100% were *P. vivax* 0% were *P. falciparum*. While 4 cases were positive male, 100% were *P. vivax*, 0% were *P. falciparum* **(Table 5)**.

Table 4: Percentage of month-wise prevalence of malaria in the general population during the year 2023 at Pir Abdul Qadir Shah Jeelani Institute of Medical Science, Gambat, Sindh, Pakistan.

Months	Total recorded persons	+ve Females		+ve Males	
		P. vivax	*P. falciparum*	*P. vivax*	*P. falciparum*
January	39	3(100%)	0(0%)	6(54%)	3(27%)
February	57	8(88%)	1(11%)	10(90%)	1(1%)
March	63	10(83%)	2(16%)	13(86%)	2(13%)
April	49	8(88%)	1(11%)	10(76%)	3(23%)
May	40	2(66%)	1(33%)	6(100%)	0(0%)
June	48	10(83%)	2(16%)	10(83%)	2(16%)
July	58	10(100%)	0(0%)	6(100%)	0(0%)

4. Discussion

Malaria is a vector-borne, life-threatening disease that occurs due to *Plasmodium* spp. Six species of *Plasmodium* are known to cause malaria in humans, i.e., *P. vivax*, *P. falciparum*, *P. malariae*, *P. ovale curtisi*, *P. wallikeri* and *P. knowlesi* (Baird et al. 2007). Among all, *P. falciparum* can cause severe anemia and malignant tertian malaria, while *P. vivax* causes less anemia and causes benign tertian malaria (Hoffman and Richie 2003). In the statement by the WHO, between 300 and 500 million cases of malaria are reported worldwide each year. Sub-Saharan Africa is the area most impacted. An estimated 1 to 2 million people die annually, mostly young toddlers and babies. Malaria remains a major source of morbidity in Pakistan and is a severe health problem (Malik, Awan, and Khan 2012). Frequent floods in Pakistan have been linked to a significant rise in malaria cases. Climate change, poor vector management, and insufficient health care are most likely to be blamed for malaria cases (Hussain et al. 2021).

In various provinces of Pakistan, considerable work has been done on the different aspects of malaria patients, including (Hussain et al. 2021), (Kaura Taruna et al. 2019), and (Asad et al. 2021), to provide a better understanding of the prevalence of malaria in the various provinces of Pakistan. The data (primary) was gathered during the month of August to September 2023. Out of the 200 patients that were suspected, 40% tested positive for the malaria parasite, with 40% prevalence rate, whereas 60% tested negative. The calculated prevalence rate in the present study was higher than the calculated prevalence rate of (Nwaneli et al. 2020; Farooq Rahman et al. 2010), which was 20% and 1.67%, respectively, while lower than the prevalence rate of (Jennifer and Dogara 2016) with 51%. The difference in the prevalence rate may be due to variations in study design, sample size, study area, participant sociodemographic characteristics or socioeconomic level, regional ecological variations, differences in vector species composition, and diagnostic methodologies, which could all contribute to the observed variations in prevalence. The present study indicates that malaria was most prevalent in males 52% as compared to females, 28%. The ratio of male malaria patients was high. This may be because of their work in fields that make them more prone to mosquitoes. In some other research papers, these reasons are also described, which indicate the greater susceptibility of males than

Table 5: Age-wise percentage of *Plasmodium vivax* and *Plasmodium falciparum* in male and female from August to September 2023 at Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences.

Age group	+ve Females		+ve Males	
	P. vivax	*P. falciparum*	*P. vivax*	*P. falciparum*
1 to 10	21(91.6%)	2(8.6%)	33(94.2%)	2(5.7%)
11 to 20	2(66.6%)	1(33.3%)	7(77.8%)	2(22.2%)
21 to 30	1(100%)	0(0%)	4(100%)	0(0%)
31 above	1(100%)	0(0%)	4(100%)	0(0%)

females due to their lifestyle and occupation (Okiring et al. 2022). Among the positive cases (36.5%) were found *P. vivax* and (3.5%) *P. falciparum.* In females (89.2%) *P. vivax* and (10.7%) were *P. falciparum* meantime in males (92.3%) *Plasmodium vivax* and (7.6%) were found *plasmodium falciparum* These findings are consistent with previous study which also recorded the higher infection rate (54.7%) in males than (45.2%) in females, mainly infected by *P. vivax* (94.2%) and *P. falciparum* (5.6%), in district Kohat, which support our current results with little variations (Khan et al. 2024). Meantime patients were divided into four age groups of 1–10, 11–20, 21–30, and 31 and above years, although malaria can infect people at any age, but it was found most prevalent in age group 1-10 years with high number of cases 58 and 29% prevalence was observed which was similar to the findings of (Shafiqur Rahman et al. 2017) with 33% prevalence in age group of 1-10 years. This may be because children have low immunity. The findings underscore the importance of targeted malaria control and prevention strategies in high-risk groups and peak seasons. Whereas secondary data bases on hospital records were collected from January 2022 to July 2023. The records of 970 suspected people were taken later they were sorted out for positive and negative cases. In primary data, maximum prevalence was found in month of August 2023 (44%) followed by September 2023 (36%). is 14.2%. The prevalence in 2022 was calculated in females as 10.2% while in males 14.2%. While in 2023, the prevalence was calculated in females 16.3% while in males 20%. In general, the differences in prevalence of secondary data may be due to studies conducted in various places or variations in the study area, sample size, economic pattern of population or other reasons. Patients suffered from malaria mostly during the summer season and were infected due to an unhygienic environment and stagnant water. On the other hand, *P. falciparum* is a tropical species that cannot survive in temperate climates. It is formed sexually and takes at least 10 days for the host to create gametocytes. Prior research carried out in Pakistan has demonstrated that *P. vivax* was more common (71.7%) than *P. falciparum* (28.2%). According to a survey, Pakistan's most common species is *P. vivax* and the present study, which was conducted at Gambat, Pakistan, has also recorded maximum cases with 36.5% of *P. vivax*, which shows these findings were consistent with previous studies.

5. Conclusion

The present study concludes that in primary data, out of 200 clinically suspected cases of malaria, (40%) were malarial positive and (60%) were negative. *P. vivax* was found to be the predominant species of *P. falciparum* in Gambat city. The male individuals (52%) were more commonly affected than female (28%) in studied population. However, in primary data the prevalence rate was calculated to be 40%. Whereas the age is concerned, the high number of cases was reported in children having age 1-10 years. The cases of malaria were obtained more in the month

of August, followed by in the month of September. In primary data, maximum prevalence was found in the month of August 2023 (44%) followed by September 2023 (36%). While in secondary data maximum prevalence was found in month of October 2022 (68%) followed by March 2023 (27%). These findings can guide local malaria control programs or awareness initiatives. However, comprehensive longitudinal studies may be conducted to monitor the changes in malaria incidents, prevalence, and transmission patterns over time.

Conflict of Interest

All authors declare no conflict of interest.

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NA

Ethical Approval

The ethical approval was obtained from the ethical committee of the University.

Consent Forms

Informed verbal consent was obtained from the participants attending the OPD.

Author Contributions

Contributed equally to this work and are co-first authors. Conceptualization, methodology, investigation, and data curation were performed by SNH. Statistical analysis, software use, and validation were carried out by TB and RK. Writing of the original draft was authored by SW and TW. Review and editing, visualization, supervision, and project administration were performed by KHM.

Data Availability

Available on request to the corresponding author.

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References

Adak, T, O P Singh, M K Das, Suman Wattal, and Nutan Nanda. 2005. "Comparative Susceptibility of Three Important Malaria Vectors Anopheles Stephensi, Anopheles Fluviatilis, and Anopheles Sundaicus to Plasmodium Vivax." *Journal of Parasitology* 91 (1): 79–82.

Baird, J Kevin, Eli Schwartz, and Stephen L Hoffman. 2007. "Prevention and Treatment of Vivax Malaria." *Current Infectious Disease Reports* 9 (1): 39–46.

Chu, Xue-Mei, Cong Wang, Wen-Ling Wang, Li-Li Liang, Wen Liu, Kai-Kai Gong, and Kun-Lai Sun. 2019. "Triazole Derivatives and Their Antiplasmodial and Antimalarial Activities." *European Journal of Medicinal Chemistry* 166:206–23.

Cox, Francis E G. 2010. "History of the Discovery of the Malaria Parasites and Their Vectors." *Parasites & Vectors* 3 (1): 5.

Hashem, Anwar M, Badrah S Alghamdi, Abdullah A Algaissi, Fahad S Alshehri, Abdullah Bukhari, Mohamed A Alfaleh, and Ziad A Memish. 2020. "Therapeutic Use of Chloroquine and Hydroxychloroquine in COVID-19 and Other Viral Infections: A Narrative Review." *Travel Medicine and Infectious Disease* 35:101735.

Hoffman, Stephen L, and Thomas L Richie. 2003. "Disease States and Vaccines: Selected Cases: Part I. Malaria." In *The Vaccine Book*, 291–310. Elsevier.

Hussain, Muhammad, Abdul Fatah, Waqas Akhtar, Farah Javeed, Muhammad Kashif, and Waqas Ahmed. 2021. "Malarial Infection in Population of District Umerkot, Sindh & Its Effects on Hematological Parameters." *Pakistan Journal of Pathology* 32 (1): 15–18.

Imtiaz, Farukh, Nighat Nisar, Khalid Shafi, and

Faryal Nawab. 2015. "Knowledge and Practices Regarding Malaria Control and Its Treatment among Patients Visiting Outpatient Clinics of Civil Hospital Khairpur." *Ann. Abbasi Shaheed Hosp. Karachi Med. Dent. Coll* 21:221–27.

Iram, Shagufta, Muhammad Saeed, Shahida Hussain, Ayesha Mobeen, Rabia Jabbar, and Maleeha Aslam. 2016. "Burden of Malarial Parasitemia: Among Healthy Population Of Lahore." *The Professional Medical Journal* 23 (04): 428–33.

Jennifer, Ocheje Ajifa, and Mustapha Musa Dogara. 2016. "Prevalence of Malaria and Risk Factors among Patients Attending Gutse General Hospital, Jigawa State, Nigeria." *International Research Journal of Public and Environmental Health*.

Karim, Asad Mustafa, Muhammad Yasir, Tanveer Ali, Sumera Kausar Malik, Irfan Ullah, Naveeda Akhtar Qureshi, Huang Yuanting, Esam I Azhar, and Hyung Jong Jin. 2021. "Prevalence of Clinical Malaria and Household Characteristics of Patients in Tribal Districts of Pakistan." *PLoS Neglected Tropical Diseases* 15 (5): e0009371.

Kaura, Taruna, Jaspreet Kaur, Ayush Sharma, Ashish Dhiman, Mangesh Pangotra, A K Upadhyay, Gagandeep Singh Grover, and Surya K Sharma. 2019. "Prevalence of Submicroscopic Malaria in Low Transmission State of Punjab: A Potential Threat to Malaria Elimination." *Journal of Vector Borne Diseases* 56 (1): 78–84.

Khan, Muhammad Imran, Humera Qureshi, Suk Joo Bae, Adil Shah, Naveed Ahmad, Sadique Ahmad, and Muhammad Asim. 2024. "Dynamics of Malaria Incidence in Khyber Pakhtunkhwa, Pakistan: Unveiling Rapid Growth Patterns and Forecasting Future Trends." *Journal of Epidemiology and Global Health* 14 (1): 234–42.

Khan, Nayab, Arshia Sumbal, and Tahseen Ara. 2020. "Malarial Prevalence in Balochistan Province, Pakistan (2002-2020)."

Malaria Annual Report (2019) Directorate of Malaria Control. Pakistan 2019. http://dmc.gov.pk/documents/pdfs/Pakistan%20Malaria%20Annual%20Report%202019%20(002).pdf

Malik, Sadia Mariam, Haroon Awan, and Niazullah Khan. 2012. "Mapping Vulnerability to Climate Change and Its Repercussions on Human Health in Pakistan." *Globalization and Health* 8 (1): 31.

Nwaneli, E I, I Eguonu, J C Ebenebe, C D I Osuorah, O C Ofiaeli, and C A Nri-Ezedi. 2020. "Malaria Prevalence and Its Sociodemographic Determinants in Febrile Children-a Hospital-Based Study in a Developing Community in South-East Nigeria." *Journal of Preventive Medicine and Hygiene* 61 (2): E173.

Okiring, Jaffer, Adrienne Epstein, Jane F Namuganga, Emmanuel V Kamya, Isaiah Nabende, Martha Nassali, Asadu Sserwanga, Samuel Gonahasa, Mercy Muwema, and Steven M Kiwuwa. 2022. "Gender Difference in the Incidence of Malaria Diagnosed at Public Health Facilities in Uganda." *Malaria Journal* 21 (1): 22.

Qureshi, Naveeda Akhtar, Huma Fatima, Muhammad Afzal, Aamir Ali Khattak, and Muhammad Ali Nawaz. 2019. "Occurrence and Seasonal Variation of Human Plasmodium Infection in Punjab Province, Pakistan." *BMC Infectious Diseases* 19 (1): 935.

Rahman, Shafiqur, Fazal Jalil, Hidayat Khan, Muhammad Ayub Jadoon, Ikram Ullah, Mujaddadur Rehman, Abdul Majeed Khan, Adnan Khan, Azam Hayat, and Zaffar Iqbal. 2017. "Prevalence of Malaria in District Shangla, Khyber Pakhtunkhwa, Pakistan." *Jezs* 5:678–82.

Snow, Robert W, Carlos A Guerra, Abdisalan M Noor, Hla Y Myint, and Simon I Hay. 2005. "The Global Distribution of Clinical Episodes of Plasmodium Falciparum Malaria." *Nature*

434 (7030): 214–17.
Soomro, Farooq Rahman, Ghulam Murtaza Pathan, Amar Lal Gurbakhshani, and Juma Khan Kakar. 2010. "Prevalence of Malarial Parasites in Larkano District, Sindh, Pakistan." *Gomal Journal of Medical Sciences* 8 (2).
WHO. Global malaria report 2023. Geneva: World Health Organization; 2023. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2023 .
World Health Organization. Malaria rapid diagnostic test performance: results of WHO product testing of malaria RDTs: round 7 (2016-2017).
World Health Organization. World malaria report. Geneva: World Health Organization; 2019.
World Health Organization. World malaria report. ISBN 978-92-4-004049-6 (electronic version) ISBN 978-92-4-004050-2 (print version) World Health Organization; 2021.
World Health Organization. World malaria report: summary (No. WHO/HTM/GMP/2015.2). World Health Organization 2014.
Yasinzai, M I, and J K Kakarsulemankhel. 2008. "Prevalence of Human Malaria Infection in Pakistan: District Dera Murad Jamali." *Pakistan Journal of Science* 60 (2): 67–68.