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PREVALENCE OF MALARIA IN DISTRICT BANNU, KHYBER PAKHTUNKHWA (KP), PAKISTAN

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Abstract

Malaria is a life-threatening disease caused by Plasmodium parasites, which are spread to people through the bite of infected female anopheles' mosquitoes. Malaria in Pakistan remains the fourt largest cause of death among communicable disease. The current study was conducted during March to August 2025 in Women and Children Teaching Hospital (WCTH) in district Bannu for the assessment of current status of malaria age-wise, gender-wise and based on pregnancy (pregnant vs. non-pregnant females). In the present study which is

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conducted in District Bannu total 222165 Malaria patients were tested from 2021-2024. Among these 8355 (3.76%) were positive, 8296 (99.29%) were infected by P.vivax while 58 (0.69%) were suffered from P.falciparum, only 1 (0.02%) Malaria patient was infected by both P. vivax and P. falciparum. Out of the positive patients 4699 (56.24%) were males while 3656 (43.75%) were females, and 5457 (65.31%) patients have age group >15 years, 1996 (23.90%) pateints have age group 4-14 years, while 902 (10.80%) pateints have age of 0-4 years. Out of the positive females 77 (2.10%) were pregnant females while 3579 (97.90%) were non-pregnant. The findings revealed that P. vivax was more prevalent compared to P. falciparum across most groups. Among age categories, elderly individuals (having age >15 years) were more commonly affected, followed by adults (having age 4-14 years) while children (having age 0-4 years) showed lower infection rates. In terms of gender, males were more affected then females. Additionally, non-pregnant females had a higher infection rate than pregnant females. Better management and awareness protect the people District Bannu from mosquito bites and ultimately reduce the risk of malaria infection in the area.

INTRODUCTION

Malaria is a parasite disease spread by insects and caused by a species of Plasmodium. A lot of people get sick and die from it in developing countries. The illness has been steadily spreading, and Pakistan is among the countries hit by the worst . The Phylum Apicomplexa is a heterogeneous group comprising several species, notably parasites, including the Plasmodium family, which is accountable for malaria transmission. There are around 250 recognized kinds of Plasmodia, and out of them, five are known to cause diseases in humans. These five species are known as Plasmodium: falciparum (Pf), vivax (Pv), anomalum (Po), malariae (Pm), and knowlesi (Pk). Plasmodium knowlesi is a zoonotic parasite that sporadically affects people and is transmitted by animals. P. falciparum is the main culprit behind most deaths caused by malaria.

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The species is highly prevalent in sub-Saharan Africa and Southeast Asia, exhibiting a significant level of dominance. The dissemination of Plasmodium falciparum poses a significant risk to the worldwide management of malaria. Pakistan has around 500,000 cases of malaria infection each year(Akhtar et al., 2024). Amongst two worldwide prominent Plasmodium species. *P. Vivax* is considered most frequent in Pakistan. Accounting for 80% of all cases of malaria, Wherease *P. Falciparum* is responsible for infecting about 20% of cases worldwide. Malaria transmission is seasonal, and specific to geographical Areas of Pakistan, Khyber Pakhtunkhwa, Sindh and Baluchistan, are prone to outbreaks. However, Khyber Pakhtunkhwa province, three malarias – endemic regions are more vulnerable: Bannu, Dera Ismail khan, and Lakki Marwat. The *P. vivax* high transmission occurs between June and September and between June and April. Similarly, the predominant period of transmission of *P. Falciparum* in Pakistan is August to December (M. I. Khan et al., 2023).

Malaria in Pakistan remains the fourt largest cause of death among communicable disease, and along with Afghanistan, Somalia, Sudan and Yemen, it accounts for more then 95% of the total regional malaria burden. The country has a reported the National Parasite incidence (API) averaging at 1.66 per 1000 population. *Plasmodium vivax* (accounting for >80% cases) and *P. Falciparum* are the only known prevalent species for malaria in Pakistan (Jahan et al., 2019).

Malaria is a major issue in Pakistani public health due to factors such as heavy irrigation, a lack of proper transportation, and the possibility of an endemic outbreak during the monsoon season6. Malaria poses a threat to 177 million out of Pakistan's 180 million population. The annual estimated and confirmed cases of malaria in Pakistan are over 3.5 million, making the nation an endemic zone for the disease. Plasmodium vivax is more common than Plasmodium falciparum in Pakistan. Baluchistan, southern Punjab, and Sindh province are the most common

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locations for Plasmodium falciparum to be detected. Malaria is most common in areas close to the Iranian, Pakistani, and Afghan borders. For the most part, P. vivax and P. falciparum tend to congregate in these regions(Akhtar et al., 2024).

The provinces of Khyber Pakhtunkhwa, Sindh, and Baluchistan, as well as the tribal territories under federal authority, are the region's most severely impacted. The prevalence of malaria in this location can be attributed to the abundant stagnant water, which serves as an ideal breeding ground for Plasmodium. Despite the implementation of a well-established malaria control program in Pakistan, an annual fatality rate of 50,000 owing to malaria has been calculated. The reason for this is the recurring floods in recent years, the emergence of resistance in P. falciparum to Chloroquine, and the ongoing influx of Afghan refugees to Pakistan who are carriers of the P. falciparum organism, which is prevalent in Afghanistan (Karim et al., 2021).

Despite continuous efforts by national and provincial health authorities, malaria remains a persistent public health concern in various regions of Pakistan, including Khyber Pakhtunkhwa. District Bannu, with its unique climatic conditions, socioeconomic challenges, and limited healthcare access, presents a high-risk area for malaria transmission. Understanding the current prevalence and identifying the key risk factors associated with malaria in this region are essential for implementing targeted control strategies. Therefore, this study aims to evaluate the prevalence of malaria and to assess the contributing risk factors in District Bannu, providing valuable insights to support evidence-based interventions and improve malaria prevention and control programs in the area. The objectives of this research are to investigate the current status of malaria and to assess the associated risk factors contributing to its prevalence in District Bannu.

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Materials and Methods

Study area

The study was conducted in District Bannu, lies diagonally in between the 31.280° North latitude and 73.250° East longitudes. It is situated in the Southern region with its borders contain Karak, Lakki Marwat district and the North south Waziristan Agencies. The total area of district Bannu is 1227 square kilometer, but the cultivated area is 74196 Hectors. The climate is warm in summer (48 °C) and cooled in winter (6 °C) Season.

Blood samples collection

The present study was conducted in Women and Children Teaching Hospital (WCTH) Bannu to make comparison between two common malaria causing parasites *P.vivax* and *P.falciparum* in District Bannu. For this study those individauls were selected who visited the hospital with complaints of fever, nausea, jaundice, headache, anemia and shivering.

Slides preparation

From each patient 2 mL blood was taken in a sterile syringe. The slides were washed with distilled water, then added blood on it, and allowed it to dry, and was stained with Giemsa'stain, then analyzed those slides in hospital laboratory to identify the two different species of malaria parasite (*P.vivax* and *P.falciparum*).

Microscopy/Parasite count

After preparation of the slides one drop of immersion oil was added to the slides and observed by microscope at the lense power of 100X. The *P.vivax* appeared clearly in large ring form, one or more ring forms may appeared in single RBC. While *P.falciparum* appeared in very small ring forms, multiple ring forms may be seen in a single RBC.

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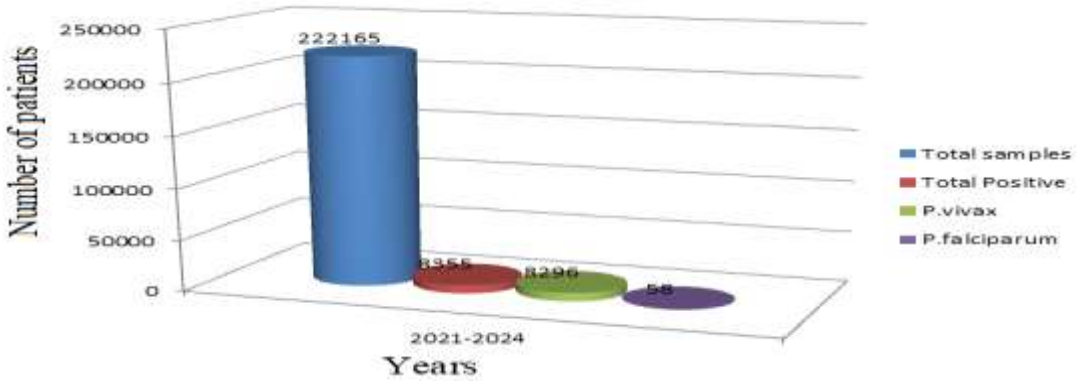
Result

In the present study total 222165 Malaria patients were tested from 2021-2024. Among these 8355 (3.76%) were positive, 8296 (99.29%) were infected by *P.vivax* while 58 (0.69%) were suffered from *P.falciparum,* only 1 (0.02%) Malaria patient was infected by both *P. vivax* and *P. falciparum,* shown in figure1.

Figure 1: Overall prevalence of malaria



In 2021 the total cases of Malaria patients tested were 51462 (23.16%) out of which 1262 (2.45%) were positive, 1253 (99.28%) of the positive cases were suffered from *P. vivax* while 9 (0.72%) of that were suffered from *P. falciparum,* no one patient was found who is infected by both *P. vivax* and *P. falciparum*. In 2022 the total cases of Malaria patients tested were 53626(24.13%) out of which 1107 (2.06%) were positive, 1102 (99.54%) of the positive cases were suffered from *P. vivax* while 5 (0.46%) of that were suffered from *P. falciparum*, no one patient was found who is infected by both *P. vivax* and *P. falciparum*. In 2023 the total cases of Malaria patients tested were 66756(30.04%) out of which 2816 (4.21%) were positive, 2791 (99.12%) of the positive cases were suffered from *P. vivax* while 24 (0.86%) of that were suffered from *P. falciparum*, only one patient was found who is infected by both *P. vivax* and *P. falciparum*. In 2024 the total cases of Malaria patients tested were 50321(22.65%) out of

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which 3170 (6.30%) were positive, 3150 (99.36%) of the positive cases were suffered from *P. vivax* while 20 (0.64%) of that were suffered from *P. falciparum*, no one patient was found who is infected by both *P. vivax* and *P. falciparum* shown in table 1.

Table 1: Species and year wise prevalence of malaria.

Year	2021	2022	2023	2024	Total
Tested	51462	53626	66756	50321	222165
Positive	1262(2.45%)	1107(2.06%)	2816(4.21%)	3170(6.30%)	8355
P.vivax	1253(99.28%)	1102(99.54%)	2791(99.12%)	3150(99.36%)	8296
P.falciparum	9(0.72%)	5(0.46%)	24(0.86%)	20(0.64%)	58
Mixed	0	0	1(0.035%)	0	1

Total positive cases were 1262, in which male cases are 704 (55.78%), while female cases are 558 (44.22%) reported in 2021. Total positive cases were 1107, in which male cases are 658 (59.44%). While female positive cases are 449 (40.56%) reported in 2022. Total positive cases were 2816, in which male positive cases are 1650 (58.59%). While female positive cases are 1166 (41.41%) reported in 2023. Total positive cases were 3170, in which male positive cases are 1687 (53.21%), While female positive cases are 1483 (46.79%) reported in 2024. The number of malaria cases increased significantly from 2022 to 2024. Male patients are consistently higher than Female patients each year. The highest cases were reported in 2024 (male: 1687, female: 1483) while 2022 had the lowest total cases shown in table 2.

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Table 2: Gender wise prevalence of malaria

	2021		2022		2023		2024	
	Sex		Sex		Sex		Sex	
	Male positive	Female positive	Male positive	Female positive	Male positive	Female positive	Male positive	Female positive
	704 (55.78%)	558 (44.22%)	658 (59.44%)	449 (40.56%)	1650 (58.59%)	1166 (41.41%)	1687 53.22%)	1483 (46.78%)
Total	1262		1107		2816		3170	

Total malaria positive cases reported in 2021 were 1262 (2.45%), in which group of age 0-4years consists of 91 (7.21%) patients, group of age 4-14years have no patients, while the group having age >15years consists of 1171 (92.79%) patients. Total malaria positive cases were 1107 (2.06%), in which the group of age 0-4years consists of 120 (10.84%) patients, group of age 4-14years have 298 (26.92%) patients while the group having age > 15years contain 689 (62.24%) patients reported in 2022. Total malaria positive cases reported in 2023 were 2816 (4.21%), in which the group of age 0-4years consists of 379 (13.45%) patients, group of age 4-14years having 819 (29.08%) patients while the group having age >15years consists of 1618 (57.46%) patients. Total

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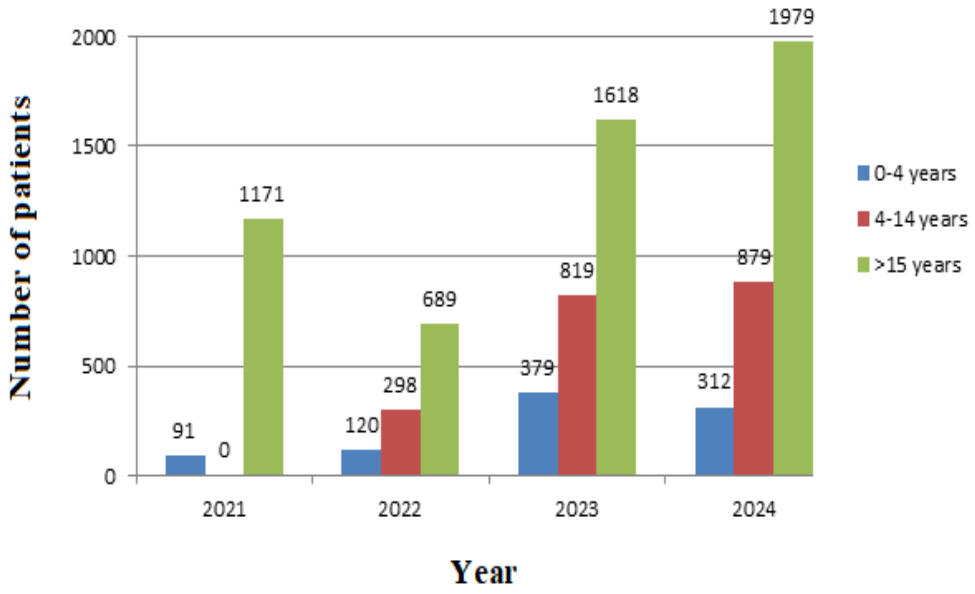
malaria positive cases were 3170 (6.30%), in which the group of age 0-4years have 312 (9.84%) patients, group of age 4-14years consists of 879 (27.73%) patients while the group having age >15years contain 1979 (62.43%) patients reported in 2024. The group having age >15years consistently has the highest number of Malaria cases each year. There is a gradual increase in malaria cases across all age groups from 2021 to 2024, shown in figure 2

Figure 2: Age wise distribution of positive cases



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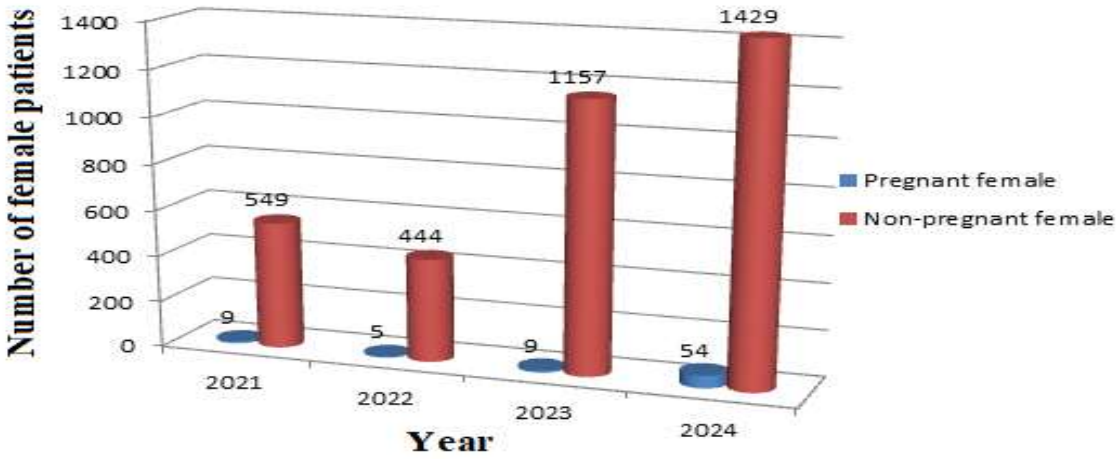
The 2.1 chart shows the number of malaria cases in females, separated into pregnant and non-pregnant groups from 2021-2024. According to report in 2021, total 558(44.21%) females had positive malaria test, out of which 9(1.61%) were pregnant and remaining 549(98.39%) were non-pregnant. Total 449(40.56%) females had positive malaria test reported in 2022, out of which 5(1.11%) were pregnant and remaining 444(98.88%) were non-pregnant. Total 1166(41.40%) females had positive malaria test, out of which 9(0.77%) were pregnant and remaining 1157(99.22%) were non-pregnant reported in 2023. According to report in 2024, totally 1483(46.78%) females had positive malaria test, out of which 54(3.64%) were pregnant and remaining 1429(96.36%) were non-pregnant, shown in figure 3.

Figure 3: Pregnant and non-pregnant wise distribution



Discussion

In the current study total 2,22,165 patients were tested, among these 8,355 (3.76%) were positive and 2,13,810 (96.24%) were negative during 2021-2024years. Among positive cases 8296 (99.29%) were suffered from *P. vivax and* 58 (0.69%) were infected by *P. falciparum,* but only 1 (0.02%) infected by both. This study showed that malaria affects

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both male and female. Further it revealed that male is more at risk then female, because out of total 8355 positive cases, 4699 (56.24%) were males and 3656 (43.76%) were females. Similarly reported by Khan et al,2016, that our study showed that malaria affects both the male and female genders and children as well. Further it is revealed that male is more at risk then female because out of 180 samples 144 (80%) cases were recorded. While female out of 150 showed that 102(68%) and children also are at risk like out of 170 samples 119(70%) positive cases (A. Q. Khan et al., 2016).

Also reported in karak by Daud et al, 2014, that male incidence high then female. Similarly, in Lal Qila reported by Dir Ahmad et al, that male is at risk then female. Tareen and co-workers also reported in Queta Baluchistan that male is most prone rather than female. The study evaluates the reason that male are more exposed than female. Male mostly work in field, farm etc. while female of that Areas mostly work in the home and they are properly covered(Nadeem, Khattak, Zeeshan, Awan, & Yaqoob, 2021). Mosquitoes are distributed all around the world with around 3,537 described species and 112 genera reported so far. Mosquitoes are responsible for many vector-borne diseases/pathogens such as malaria, Dengue fever virus, West Nile virus Francisella tularensis, Wuchereria bancrofti etc. Almost 700 million people around the globe are being encountered by mosquitoes on yearly basis (Hayat et al., 2019).

Asif et al.,2008 reported, Overall, 21.1% of the cases were positive by at least one method. Bannu was considered as one of the most malarious areas of the province. According to Ministry of National health (MOH), 2010-2015, World health organization (WHO), 2011 and Zakeri s et al, 2006, In previous study, *P. vivax* cases peaked in the summer month (August) while P. falciparum and mixed infections in winter (October).

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Similar distribution trends are known to exist in certain areas of neighboring Afghanistan that share similar climatic settings.

Conclusion

The present study was conducted to compare the prevalence of *P. vivax* and *P. falciparum* in District Bannu across different population groups. The data was analyzed age-wise, gender-wise and based on pregnancy status (Pregnant vs Non-pregnant women). The findings revealed that *P. vivax* was more prevalent compared to *P. falciparum* across most groups. Among age categories, elderly individuals (having age >15 years) were more commonly affected, followed by adults (having age 4-14 years) while children (having age 0-4 years) showed lower infection rates. In terms of gender, males were more affected then females,(because males are more exposed to mosquito then females in District Bannu, and the other reason is male have testosterone hormone which act as a immune suppressive agent). Additionally, non-pregnant females had a higher infection rate than pregnant females. Now I would like to suggest to the government to improve the drainage system in District Bannu to prevent the accumulation of stagnant water, which serves as a breeding ground for mosquitoes. Additionally, the government should distribute mosquito nets, especially among poor people of District Bannu. If possible, during the mosquito season (especially in summer) Aerial spraying through helicopters should be arranged to control the mosquito population. These actions will help the people of District Bannu to protect from mosquito bites and ultimately reduce the risk of malaria infection in the area.

Recommendations

Based on the findings of this study, it is recommended that health authorities strengthen malaria surveillance and diagnostic facilities in District Bannu to ensure early detection

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and prompt treatment of cases. Community awareness programs should be enhanced to promote preventive measures such as the use of insecticide-treated bed nets, indoor residual spraying, and elimination of mosquito breeding sites. Regular monitoring of climatic and environmental conditions linked to malaria transmission is essential for timely interventions. Collaboration between healthcare providers, local government, and non-governmental organizations should be encouraged to improve access to healthcare and implement targeted vector control strategies. Furthermore, continued research and data collection should be prioritized to evaluate the effectiveness of current control measures and support evidence-based policymaking for malaria prevention in the region.

Future Research

Future research should aim to investigate the genetic diversity and drug resistance patterns of *Plasmodium* species circulating in District Bannu to improve treatment effectiveness. Studies focusing on the impact of environmental changes, population movement, and socioeconomic factors on malaria transmission dynamics will provide deeper insights into local risk patterns. Additionally, integrating advanced molecular diagnostic tools and GIS-based mapping can help identify high-risk zones and predict future outbreaks. Long-term cohort studies are also needed to monitor the effectiveness of current control measures and to design sustainable malaria elimination programs tailored to the specific needs of Bannu and similar endemic regions of Khyber Pakhtunkhwa.

Authors' Contribution

All authors contributed significantly to this research work. The first author conceptualized the study, designed the methodology, and collected the field data. All authors reviewed,

refined, and approved the final version of the paper before submission and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this research paper. All authors have conducted the study objectively and report no financial, personal, or professional relationships that could influence the findings or interpretation of the results.

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