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Malaria: Still a Health Problem in the General Population of Bannu District, Khyber Pakhtunkhwa, Pakistan

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Authors' contributions

This work was carried out in collaboration between all authors. Author SNK participated in the study design, data analysis and drafted the manuscript. Authors SA and SK participated in the experimental work. Authors S. Attaullah and MAK carried out the manuscript writing and preparation. Authors NU and M. Amir K coordinated in the field sample collection. Author IA participated in the critical review of the manuscript. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: This study was aimed to know the burden of malaria infection and to re-evaluate its high prevalence in general population of Bannu District.
Study Design: The current study was designed to re-evaluate the high prevalence of malaria and its demography in the human population of Bannu District.
Place and Duration of the Study: This study was conducted during the months of May to September 2011 in local population of the Bannu District.
Methodology: A total of 823 blood samples were randomly collected from both sexes; 513 males and 310 females of varying age groups <1 up to 50< years (mean 26.3± 9.1). Blood

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was drawn by pricking a left hand finger by using a sterilized lancet. Both thick and thin smears were prepared and examined through microscope for the detection of malarial parasites along with their impact on the general hematology.
Results: Out of 823 blood samples, 223(27.1%) subjects were found positive for *Plasmodiasis*, while the distribution of species prevalence was observed as 186 (22.6%) and 25 (3.04%) for *Plasmodium vivax,* and *Plasmodium falciparum,* respectively along with a mixed infection of 12(1.46%). Variation with high incidence (42.65%) was found in the age group of 21-30 years. Moreover, males were found to be more malaria infected (30.64%) than females (24.95%). In addition, the prevalence of *Plasmodiasis* was found more frequent in rural population (33.42%) as compared to urban (21.00%) population.
Conclusion: The present study revealed that the burden of malaria was high in rural areas of Bannu District and more attention is needed to overcome and control the high prevalence of malaria in this region.

Keywords: Malaria; P. falciparum; P. vivax; Bannu; Khyber Pakhtunkhwa.

1. INTRODUCTION

Malaria is a Vector-borne infectious disease caused by a peripheral blood protozoan parasite of the genus *Plasmodium* [1]. Malaria is not only among the most prevalent tropical diseases worldwide [2], but it's a major threat to the public health and economic development of many nations [3]. Despite advances in medical sciences, malaria is still a global health challenge causing a death toll of approximately one million per annum [4]. More than one billion people live in areas with high malarial risk [5]. An estimated 3.3 billion people were at risk of malaria in 2010, although of all geographical regions, populations living in subSaharan Africa have the highest Risk of acquiring malaria; in 2010 81% of cases and 91% of deaths are estimated to have occurred in the WHO African Region, with children under five years of age and pregnant women being most severely affected [6]. Since malaria is more prevalent in rural areas where people do not have access to hospitals and health care hence many malaria cases remain unknown and thus the actual figures of malaria patients may be considerable more than the documented. However, its endemicity is well documented in areas like some parts of America, most of Asia, a large area of Africa and in other areas especially those located near the equator [7].

Pakistan is endemic for both *P. vivax* and *P. falciparum* [8,9]. According to the World Health Organization (WHO), 97% (approximately 150 million) of the Pakistani population is at risk of contracting malaria, with an estimated nationwide burden of 1.6 million cases per year [10]. Malaria transmission in Pakistan is markedly seasonal and prone to epidemic outbreaks in particular geographical areas, especially the Khyber Pakhtunkhwa (Formerly called NWFP), the Balochistan province and the Sindh province [11]. The main malaria transmission season is September through November, following the monsoon season. There is a brief transmission season during spring (March-April), but most of the spring cases are believed to be delayed expressions of infections acquired after the monsoon season or relapsing *P. vivax* malaria [11]. Overall *P. vivax* accounts for 75%, while *P. falciparum* accounts for 25% of the malaria burden in Pakistan [11].

Pakistan being a tropical and agricultural country where majority of population is poor and lives in the rural areas. The incidence of Increase of malaria cases in this part of the world is due to several factors including increased poverty, environmental deterioration and

particularly the spread of chloroquine resistance. Warmer autumns which favor prolonged transmission and a chronic decline in vector control activities are also contributing in the spread of malaria [12,13]. Similarly, the prevailing extensive agricultural practices, an expansive irrigation network, and the monsoon rains act together to promote a favorable environment for malaria transmission in many areas of Pakistan [14].

Pakistan is considered to be hyperendemic for malaria but the precise data on prevalence of malaria in Pakistan is lacking [15]. Most cases of malaria in Pakistan are caused by *P. vivax* though the prevalence of *P. falciparum* is on the rise and currently, it is responsible for almost 35%- 40% of the cases [8]. Keeping in view the above circumstances the present study was designed to assess the prevalent situation of malaria in the local population of Bannu district.

2. MATERIALS AND METHODS

2.1 Description of Study Area

The study was carried out in Bannu District (32º 43' - 33º 06' N; 70° 22' - 57' E), Khyber Pakhtunkhwa (KPK), Pakistan (Fig. 1). The Kurram and Gambila rivers traverse Bannu district and provide water for irrigation as well as inevitably forming breeding grounds for malaria vectors. Mean daily temperatures range between 10.8ºC – 32.9ºC. The study area experiences two rainy seasons: in March and during the summer monsoon that occurs in July and August [11].

Fig. 1. Map of Pakistan showing the study area in Khyber Pakhtunkhwa

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2.2 Sample Collection

A total 823 blood samples were randomly collected from different localities of Bannu district in a span of four months from May 2011 to September 2011. All the subjects in the study

were recruited from the Bannu Women and Children Hospital (BWCH). The hospital's catchment area covered the entire district of rural and urban areas. After taking the informed consent, the clinical history with sign and symptoms of all the subjects were recorded on separate data sheet with the assistance of the Malaria Control Laboratory of BWCH. A sample of 3ml blood of each subject in the EDTA sterilized tube was then brought to the Molecular Parasitology and Virology Laboratory of the Department of Zoology, Kohat University of Science and Technology for further experimental analysis.

2.3 Slide Preparation

Blood was drawn by pricking a finger usually from the fourth finger of the left hand using a sterilized lancet. Each lancet was used only once. After cleaning the finger with spirit-moisten cotton, pricking was carried out and the first drop of blood was removed with cotton. Both thick and thin blood films were prepared, stained with Giemsa's and examined under the binocular microscope (CX 31 Japan) with a 100X oil immersion lens for the detection of various stages of malarial parasites. The method of total Parasite density and hematological analysis were calculated by using the method of O' Meara et al. [16].

2.4 Statistical Analysis

The data were statistically analyzed with the assistance of SPSS (Version 16) by using the Chi square t test. P values less than 0.05 were considered to be statistically significant.

3. RESULTS AND DISCUSSION

Malaria is quite common in Pakistan. Epidemiological data from different regions of Pakistan are insufficient to exactly assess the prevalence of various types of malaria [17]. In Pakistan malaria infection is highly endemic. In terms of prevalence in Pakistan there is variation from one district to another and province to province [18]. In the developing countries including Pakistan malaria infection is still mostly prevalent. Although significant measures have been made for the control of malaria, still it remains a frequent health problem in the highly epidemic region of the Southern belt of Khyber Pakhtunkhwa. A total of 823 blood samples were randomly collected from the varying age groups <1 to 50 years (mean 26.3± 9.1) of both sexes (Male = 513 and Female = 310) residing in different localities of both rural and urban areas of Bannu District. Out of the 823 samples, 223 (27.1%) were found to be positive. Similar studies regarding the incidence and burden of malaria infection were also found in the past in different zones of Pakistan [9,19-21].

In this study among the 223 positive malaria samples, *P.vivax* was found to be more prevalent and wide spread one 186 (22.6%) as compared to *P. falciparum* 25(3.04%), while the rest 12 (1.46%) showed mixed infection of both *Plasmodium* species (Fig. 2). None of the subjects in the current study had *P. malariae* or *P. ovale* infections. Similarly high and low prevalence status of both *P.vivax* and *P. falciparum* were observed respectively, with neither *P. malariae* nor *P. ovale* infections in the highly epidemic areas of Pakistan [20,22-29]. In our study it was found that the high prevalence of *P. vivax* as compared to *P. falciparum* might be due to its greater distribution and ability to produce gametes under hot temperate conditions were the possible reasons in the studied area.

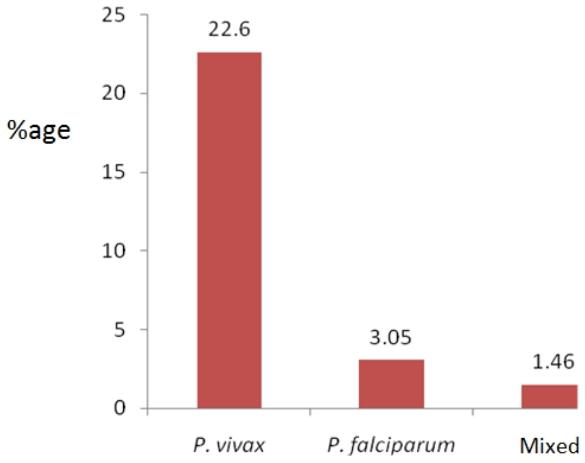

Fig. 2. Overall prevalence of malarial parasites in Bannu District

It was found in the current study that malaria can affect all the age groups of both sexes. In the present work males were found to be more infected 95/310 (30.64%) with 76 (24.5%) *P. vivax*, 11 (3.5%) *P. falciparum* and 8 (2.5%) mixed infection than 128 (24.95%) females (Fig. 3). Similar investigations in Pakistan were also reported with higher malaria prevalence in males than females' population [9,21,29]. Our findings are also quite in comparison with another study carried out in Iran where the infection showed high prevalence of malaria in male as compared to female [30,31]. However, in the present study variation with high prevalence of malaria 58/136 (42.65%) was observed in the age group of 21-30 years, while lowest 61/290 (21.03%) was found in the age group of <1-10 years of both male and female population (Table 1). The present findings are quite in line with other similar studies in the age groups of both male and female population [23,29,31]. This predominance prevalence status of malaria in males can be explained by the fact of the areas custom and tradition. In the present studied area males were more exposed to the bite of *Anopheles* as compared to females, because males went for working in the field and participated in different activities, while female were mostly restricted to their homes and traditionally well covered as compared to males.

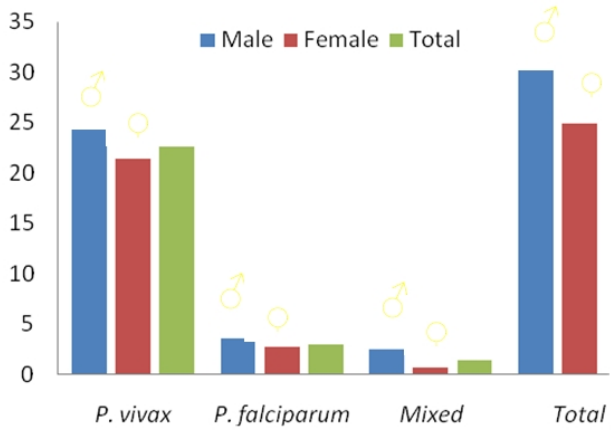

Fig. 3. Gender wise overall prevalence of malarial parasites in Bannu District

Table 1. Age wise over all prevalence of *plasmodiasis* in both male and female population of Bannu District

Gender	Age Groups	No. of Cases	*P. v* n (%)	*P. f* n (%)	Mixed n (%)	Total +ve n (%)
Male	<1-10	151	29 (19.2)	02 (01.3)	00 (00.0)	31 (20.52)
	11-20	89	22 (24.7)	02 (02.2)	01 (1.12)	25 (28.08)
	21-30	47	19 (40.4)	05 (10.6)	05 (5.61)	29 (61.70)
	31-40	13	04 (30.8)	02 (15.3)	01 (7.69)	07 (53.84)
	41-50>	10	02 (20.0)	00 (00.0)	01 (10.0)	03 (20.0)
Total		**310**	**76 (24.5)**	**11 (03.5)**	**08 (2.58)**	**95 (30.65)**
Female	<1-10	139	26 (18.7)	03 (02.1)	00 (00.0)	27 (19.42)
	11-20	141	31 (22.0)	04 (02.8)	01 (0.71)	36 (25.53)
	21-30	89	23 (25.8)	03 (03.4)	02 (2..24)	28 (31.46)
	31-40	112	23 (20.5)	03 (02.7)	01 (0.89)	27 (24.11)
	41-50>	32	07 (21.8)	01 (03.1)	00 (00.0)	08 (25.00)
Total		**513**	**110(21.4)**	**14 (02.7)**	**04 (0.78)**	**128 (24.95)**

Malaria is predominantly the disease of rural areas where more people live below the poverty line (38.65%) than in urban areas (22.39%) and, in highly endemic areas, income lost per year has been measured as 70% of per capita income [32]. We also carried out that variations were found among different localities having different environment and hygienic conditions. In the current study it was observed that in urban areas the overall prevalence of *Plasmodiasis* were 88/419 (21.0%), while in rural areas the infection was 135/404 (33.41%). The highest prevalence of malarial parasites were observed in the Locality of Shamshikhel (72%) with infection of *P.vivax* 24/50(48.0%), *P. falciparum* 08/50(16.00%) and mixed infection of both species 04/50(08.0%), while lowest infection of *P.vivax* 23/172(13.27) was found in Bannu city followed with *P. falciparum* 01/162(0.61%) in Amandi while no case of mixed infection was found in Bannu city and Amandi (Table 2). The present study is also quite in comparison with other similar studies regarding the high prevalence of malaria in the rural areas as compared to the urban areas [21,29].

Table 2. Over all Prevalence of Malarial Parasites in Urban and Rural Areas of Bannu District

Epidemic Areas	No.of samples	*P. vivax*	*P. falciparum*	Mix inf.	Total
		+ve *n* (%)	**+ve *n* (%)**	**+ve *n* (%)**	**+ve *n* (%)**
Urban areas					
Bannu city	172	23(13.27)	02(1.16)	00(00)	25 (14.53)
Kakki	88	19(21.59)	02(2.27)	01(1.13)	22 (25.00)
Surani	159	37(23.27)	03(1.88)	01(0.62)	41 (25.79)
Total	**419**	**79(18.85)**	**07(1.67)**	**02(0.47)**	88 (21.00)
Rural areas					**+ve *n* (%)**
Amandi	162	36(22.22)	01(0.61)	00(0.00)	37 (22.84)
Shamshikhel	50	24(48.00)	08(16.0)	04(8.00)	36 (72.00)
Mandan	54	11(20.37)	02(3.70)	01(1.85)	14 (25.93)
Norar	42	14(33.33)	04(9.52)	03(7.14)	21 (50.00)
Sokari	96	22(22.91)	03(3.12)	02(2.08)	27 (28.13)
Total	**404**	**107(26.48)**	**18(4.45)**	**10(2.47)**	135 (33.42)
Sub Total	**823**	**186(22.60)**	**25(3.03)**	**12(1.45)**	223 (27.10)

Regarding the clinical history, fever was common and the leading symptoms in both *P.vivax, P.falciparum* and also in mixed infections, having range from 97.5% to 100%. Other clinical symptoms apart from fever were sweating, chill/ Rigors, their range in *P.vivax* and in *P.falciparum* was 80.21% to 90.67%, 82.54% to 91.43% respectively, while in mixed infections the infection rates were 94.52% and 95.05% respectively. This high frequency may be an incidental finding or that their temperatures were recorded more vigilantly and frequently. Other symptoms were vomiting, headache; body aches are common in all the three forms (Table 3). Splenomegaly was the main and leading symptom in all the three forms having a range from 61.23% to 72.52%. Similar study was carried out in Quetta, [33], where in the patients the fever ranged from 97% to 100%. While sweating and chill/ Rigors in *P.vivax* was 76% and 81% respectively. In *P.falciparum* this was observed 91.32% and 91%, while in mixed infections sweating was 92.31% and chill was 91.21%. Splenomegaly in *P.vivax* was 59%, in *P.falciparum* was 68.81%, and in mixed infection was 73.63% [33]. In our study Splenomegaly was the main and leading symptom in all the three forms ranged from 61.23% to 72.52%.This unique finding may be due to the repeated *Plasmodium* infection as most of the subjects in this study were from highly prevalent areas of malaria. The present results also showed close similarity to the study conducted in D.I Khan [21] and Peshawar [34].

Table 3. Clinical sign and symptoms regarding *plasmodium* species (n = 223)

Parameters	*P. v* n= 186	*P.f* n = 25	Mixed n = 12	p- value
Temperature (%)	97.5	99.06	100	
Mean	98±0.5	98.5±1.0	99±1.5	
Range	100±1.9	101.3±2.5	101±2.05	0.002
Sweating (%)	80.21	90.67	94.52	NS
Chills/ Rigors (%)	82.54	91.43	95.05	NS
Vomiting (%)	46.05	55.32	37.24	0.004
Headche (%)	72.57	79.52	81.31	0.005
Abdomial Pain (%)	8.51	14.31	17.25	0.05
Diarrhoea (%)	3.42	4.2	3.62	0.03
Cough (%)	2.36	5.17	7.54	NS
Body aches (%)	41.22	45.56	48.35	NS
Hepatomegaly (%)	5.29	7.35	8.67	NS
Splenomegaly (%)	61.23	67.45	72.52	NS
Jaundice (%)	4.42	5.51	7.25	NS

**: mean ± standard deviation; NS: not significant.*

Anaemia has frequently been associated with malaria. The two common causes of anaemia are increased haemolysis and decreased rate of erythrocyte production from bone Marrow [35] whereas the malnutrition and intestinal parasitic infections aggravate this problem in highly endemic areas. White cell counts were also found reduced in all of the subjects infected with various *Plasmodium* species. This haematological alteration is certainly not unprecedented, neither for *P. falciparum* [36] nor for *P. vivax.* In the present study the mean values of WBCs and Hb level for *P.vivax* and *P. falciparum* were 5.6±1.93, 5.9±1.76, 12.34±2.46, 13.21±1.76 respectively, while in mixed infection the mean value of WBCs and HB level as compared to *P. vivax* and *P. falciparum* were 5.8±1.54, and12.51±1.92 respectively (Table 4). Similar findings were found regarding the parasitemia of *Plasmodiasis* affecting the WBCs and haemoglobin were 5.8±1.75, 5.9±1.69, 13.7±1.74, 12.43±2.24 respectively by *P. vivax* and *P. falciparum*, while in mixed infections these analysis were

5.71.60±1.60, 12.5±1.67 [33]. Anaemia was also less frequently observed in various other studies [37-39] which showed quite similarity with our findings.

Table 4. Laboratory analysis associated with plasmodiasis

Parameters		*P. v*	*P.f*	Mixed	p- value
WBC's (109/L)	Mean	5.6±1.93	5.9±1.76	5.8±1.54	
	Range	2.3-11.7	1.2-10.9	2.5-10.5	0.05
Platelet (109/L)	Mean	123.65±45.9	140.7±54.6	135.5±48.7	
	Range	14-219	16-410	22-334	0.04
% Neutrophil	Mean	60.25±11.9	62.5±13.6	63.21±14.8	
	Range	49-65	51-60	50-60	NS
Eosinophil(%)	Mean	2.1±1.8	3.4±2.8	3.2±2.3	
	Range	1-3	2-5	1-5	NS
% Lynphocytes	Mean	30.2±19.8	31.3±18.8	29.5±21.3	
	Range	21-35	23-38	25-36	NS
Hb Level (g/L)	Mean	12.34±2.46	13.21±1.76	12.51±1.92	
	Range	7.9-16	6.2-17	8.5-16	0.04
Bilirubin (mg/dL)	Mean	0.91±0.53	1.31±0.76	1.06±0.83	
	Range	0.32-3.25	0.45-15.2	0.53-7-86	0.03
Glucose (mg/dL)	Mean	93.14±24.25	97.23±21.74	95.14±20.25	
	Range	67.1-160.86	51.3-175.52	65.12-170.5	0.06

**: mean ± standard deviation; NS: not significant.(Statistical test application mentioned in Methodology)*

3. CONCLUSION

It was concluded that there were significant risk factors for malaria prevalence. The poor hygienic condition, no use of antimalarial sprays, use of irrigated land, sharing the house with livestock, improper diagnosis, high temperature of the area and load shading also play a key role for the spread of malaria in the Bannu District. The study was aimed to improve the strategic schemes for the malaria control to be customized in such a way that they could bring about a modification of these risk factors, particularly among the population who have been identified to be at greatest risk.

ETHICAL APPROVAL

The study was approved by the Institutional Review Board of Faculty, Kohat University of Science and Technology, Pakistan.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

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