

Research Article

Endemicity of malaria in the human population of district Kech, Balochistan

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Abstract

Endemicity and high transmission of malaria infection is one of major health issues in Balochistan. The current study aimed to assess and evaluate the prevalence of malarial infection in district Kech (Turbat), Balochistan. Started in June 2021 and continued till end of May 2022 by sampling 53073 subjects. The blood samples were collected by preparing thick and thin blood films for both gender (male & female) and different age groups who belong to urban and rural areas, through visiting four different laboratories and homes twice in a month. The results reveal, incidence frequency of malarial infection (positivity) was 4074 (7.68%), highly prevailing in rural area 2433 (59.72%) as compare to urban area 1641 (40.28%) wherein male 2112 (51.84%) and female 1962 (48.16%). For all that, the highest incidence rate was recorded in age group 6-20 years with 1234 (30.29%) and the lowest in 1-5 years with 345 (8.47%). The *Plasmodium vivax* ranked top with highest prevalence rate 3629 (89.13%) followed by *Plasmodium Falciparum* 424 (10.41%). Accordingly, endemicity of malaria infection remains a significant threat. Individuals in the society need to get themselves protected via practicing personal protective measure (i.e. utilizing insecticide bed nets, topical insect repellent and protecting residential regions) similarly the health consultants, NGOs and the government would play their roles completely for controlling the infection rate.

Keywords: Disease; Infection; Malarial parasite; Plasmodium species; *Plasmodium falciparum*; *Plasmodium vivax*

Introduction

Malaria is a vector-borne contagious disease which is caused via various *Plasmodium* species subfamily that is endemic to several tropical and sub-tropical countries of globe [1]. Malaria remains a threat for life and is affected by *Plasmodium* parasite infection [2]. Malaria remains a great threat to people in various corners of the globe, however, this disease emerged with a renewed vengeance in the eras since then. There are two main reasons for the revival named insecticide resistant mosquitoes and drug-resistant parasites [3].

More than 125 years after the discovery of the causative parasites, human malaria still remains a major global-health issue [4]. Most of the world's poorest habitants live in the areas where malaria is at its peak. And this results in suffering of bodily, financial and societal mishaps, forth the connection between malaria and poverty. In terms of world prospective, malaria's prevalence is considered 90% that it had victimized in the areas of Africa for the most of time. A wide range of facts do confirm the fact that there is reasonable link between malaria and economic growth in

both areas when malaria understates financial problems [5, 6]. The malarial infection frequency ratio is different during various seasons of a year [7]. Single-celled parasites of *Plasmodium* genus cause among the major infectious disease malaria. Five-specie of genus named *Plasmodium-vivax*, *Plasmodium-falciparum*, *Plasmodium-ovale*, and *Plasmodium-malariae* also *Plasmodium knowlesi* cause malaria [8].

Malaria was estimated to have 214 million clinical cases in infants that have age 5 or under years and 43800 casualties in 2015 [9]. Malaria is second-most spread infection in under developed countries [10]. In Asia, especially in Pakistan also Afghanistan, malaria until now is high problematic for public health with current transmission of every *Plasmodium Falciparum* & *Plasmodium Vivax* [8]. Pakistan is a tropical and agricultural country where majority of persons residential of rural areas with a mechanism for water system and no proper dumping of waste that increase malarial widely spread [11]. According to [7] stagnant water causes prevelance of malaria infection higher in Autumn season (August, September & October) where mosquitoes experience a groovy atmosphere for breeding and transmitting parasites (*Plasmodium*) to healthy person from infected as the highest frequency (protozoal infection, 91.0%) was detected in August and lowest frequency (57.1%) in March. Pakistan is among six Eastern Mediterranean region WHO countries having high transmission malaria and almost whole population of the country is living at danger of infection [12]. Pakistan is amongst countries that having risk of increase in this infection, in view of broad agricultural practices, massive irrigation system and rainy season, large population movements and complex political situation in certain border that add to malariogenic potentiality of the country [13]. Malaria stays one of the key health issues in Pakistan and more importantly in rural

places due to absence of amenities and understanding of health problems [11, 12]. Malaria affected by *Plasmodium Vivax* and also *Plasmodium Falciparum* are very common in Pakistan, with cerebral malaria being a significant health issue in Balochistan. *Plasmodium Vivax* and *Plasmodium falciparum* said to be the most prevailing types in Balochistan [11]. Inferring the statement of WHO, *Plasmodium Vivax* remains the most prevalent parasite amongst *Plasmodium* species in entire state including Balochistan particularly from April to September. However, *Plasmodium Falciparum* is observed ordinarily in mid of August to December, depending on particular region as higher malaria infection recorded in mountainous areas of Balochistan by and large [14, 15]. The aim of this study was to assess the endemicity of malaria infection and plasmodium species in human population of Kech (Turbat) district.

Materials and Methods

Study area

This study was carried out in district Kech, previously known as Turbat, is popular in Pakistan for romantic Sassi-Punnu story. In the year 1994-1995, district of Turbat was given the name Kech that it previously had. Having district name changed to its previous one Kech, now town of Turbat remains headquarter of district Kech, Balochistan. Makran division contains three districts named Gwadar, Kech (Turbat) and Panjgur. Turbat town can be described the center of the division in terms of geography, society and politics. District Kech has Panjgur on its north, Awaran on eastern side, Gwadar on its south and shares its border with Iran in the east. Number of sub-divisions of this district are four namely, Turbat, Tump, Buleda and Dasht [16]. The district comes into the category of sub-tropical area, with the entire sophisticated area of 65,597 hectares [17].

Study duration

This study began in June 2021 and continued till the end of May 2022 in

human population of district Kech (Turbat), Balochistan.

Sample collection

The sample collection was proceeded in two ways; active case detection (ACD) and passive case detection (PCD) using the accepted methods of Manson-Bahr and Bell [18, 19] and blood collection points/laboratories i.e. Teaching Hospital laboratory/ malaria unit Turbat, Baloch laboratory Turbat, TMC (Turbat Medical Center) laboratory Turbat and Kech laboratory Turbat and homes were visited twice in a month to inspect the presence or absence of malaria parasites in the blood samples. For further analysis all the positive slides were taken into the laboratory of Zoology department, University of Balochistan, Quetta.

Sample size

The blood sample of 53079 subjects from male and female, the opposite gender and divergent ages (age groups ranging from 1 year to above 50 years) covering both regions; urban (population, 302,136/33.23%) and rural (population, 606,980/66.77%) [17].

Isolation and identification

The blood slides (thick and thin) were prepared using the recommended method, approved by World Health Organization presented by [18]. The blood films (thick & thin) were taken two to four minutes for fixing methanol, after that were placed in a rack for approximately three to four minutes to get dry and Dilute Giemsa's stain techniques were followed, delineated by Manson-Bahr and Bell [19].

Thin blood film

Making a thin blood film we took spreader to produce a thin ribbon-like smear on the slide. The blood droplet on the glass was spread by corner of another slide. Later, the slide was kept in the open air for proper dryness.

Thick blood film

The fingertip was pricked prudently to get safe from any injury and was pressed lightly till we got the needed blood droplet on the slide. The collected blood droplet was

expanded in a small circle area with proper thickness through a clean and dry slide.

Furthermore, identification of plasmodium species (*Plasmodium Falciparum*, *Plasmodium Vavix & Mixed Infection*) was performed through the keys provided by [18, 20].

Results

The results of the present study reveal that 4074 subjects were observed malaria infected from 53073 which is 7.68% in human population of Kech (Turbat) district. The (Table 1) representing the results of study by means of month (June 2021 to May 2022), *Plasmodium* species (*Plasmodium Falciparum*, *Plasmodium Vavix & Mixed Infection*), gender (Male & Female) and urbanization (Urban & Rural areas).

The results reveal that the highest frequency of *Plasmodium* resulted in the month of September 2021 with frequency of 1264 positive cases (17.33%) and the lowest frequency in month of March 67 (3.61%). Consequently, 51.84% (2112) malaria positive cases were reported for male and 48.16% (1962) for female. Moreover, 59.72% (2433) was recorded in rural area, retaining population 606,980 (66.77%) while 40.28% (1641) in urban area where the population of the area is 302,136 (33.23%) in district Kech. As results are represented in (Table 1) and *Plasmodium* species rate portrayed in (Fig. 1 & Fig. 2) respectively.

The total population of district was divided into various age groups in this study, as 8.47% (345) was recorded for 1-5 years which is the lowest infection rate and 30.29% for 6-20 years which is the highest infection rate the age groups, 23.49% (957) for 21-35 years, 21.92% (893) for 36-50 years and 15.83% (645) for 50 years above and *Plasmodium* species for different age groups where the results of this study reveals that *Plasmodium Vavix* is most prevailing parasite at the age range from 6 to 20 years old with highest ratio (1092), detailed in (Table 2).

The data were tested and analyzed statistically by means of chi square test formula, demonstrated by Neil WA [21] in order to incur whether the any association exists among the categories of malarial infection (plasmodium species) and age groups.

$$x^2_{cal} = \sum \frac{(f_o - f_e)^2}{f_e} = 13.37637$$

The chi-square was computed for determining the association, value 13.3764 (p-value < .05) was posed statistically significant. Consequently, significant alliance was found among *Plasmodium* species about five percent level of significance. The *Plasmodium Vivax* infection stratified the highest rank in comparison.

Table 1: Malaria Infection incidence per month (Gender & Urbanization, Kech district)

Serial no.	Month	Total Slides Studies	Malaria Species	Total	Male	Female	Urban	Rural
01.	June 2021	3946	<i>P. Falciparum</i>	13	7	6	5	8
			<i>P. Vivax</i>	198	103	95	91	107
			<i>Mixed Infection</i>	3	1	2	0	3
			Total	214	111	103	96	118
02.	July 2021	3937	<i>P. Falciparum</i>	7	2	5	3	4
			<i>P. Vivax</i>	138	81	57	58	80
			<i>Mixed Infection</i>	0	0	0	0	0
			Total	145	83	62	61	84
03.	Aug 2021	5132	<i>P. Falciparum</i>	34	19	15	16	18
			<i>P. Vivax</i>	593	310	283	251	342
			<i>Mixed Infection</i>	2	2	0	1	1
			Total	629	331	298	268	361
04.	Sept 2021	7293	<i>P. Falciparum</i>	42	18	24	19	23
			<i>P. Vivax</i>	1221	603	618	448	773
			<i>Mixed Infection</i>	1	0	1	0	1
			Total	1264	621	643	467	797
05.	Oct 2021	6448	<i>P. Falciparum</i>	53	32	21	24	29
			<i>P. Vivax</i>	559	275	284	244	315
			<i>Mixed Infection</i>	2	1	1	0	2
			Total	614	308	306	268	346
06.	Nov 2021	7419	<i>P. Falciparum</i>	68	35	33	31	37
			<i>P. Vivax</i>	263	153	110	80	183
			<i>Mixed Infection</i>	3	2	1	2	1
			Total	334	190	144	113	221
07.	Dec 2021	4561	<i>P. Falciparum</i>	18	9	9	7	11
			<i>P. Vivax</i>	145	70	75	55	90
			<i>Mixed Infection</i>	4	3	1	1	3
			Total	167	82	85	63	104
08.	Jan 2022	2320	<i>P. Falciparum</i>	12	7	5	6	6
			<i>P. Vivax</i>	55	33	22	15	40
			<i>Mixed Infection</i>	1	1	0	0	1
			Total	68	41	27	21	47
09.	Feb 2022	1700	<i>P. Falciparum</i>	12	4	8	5	7
			<i>P. Vivax</i>	73	38	35	28	45

			<i>Mixed Infection</i>	0	0	0	0	0
			Total	85	42	43	33	52
10.	Mar 2022	1858	<i>P. Falciparum</i>	11	7	4	5	6
			<i>P. Vivax</i>	55	31	24	27	28
			<i>Mixed Infection</i>	1	1	0	0	1
			Total	67	39	28	32	35
11.	April 2022	4590	<i>P. Falciparum</i>	61	32	29	23	38
			<i>P. Vivax</i>	190	104	86	94	96
			<i>Mixed Infection</i>	0	0	0	0	0
			Total	251	136	115	117	134
12.	May 2022	3875	<i>P. Falciparum</i>	93	49	44	38	55
			<i>P. Vivax</i>	141	78	63	64	77
			<i>Mixed Infection</i>	2	1	1	0	2
			Total	236	128	108	102	134
Total			53079	4074	2112	1962	1641	2433
Percentage				7.68 %	51.84%	48.16%	40.28%	59.72%

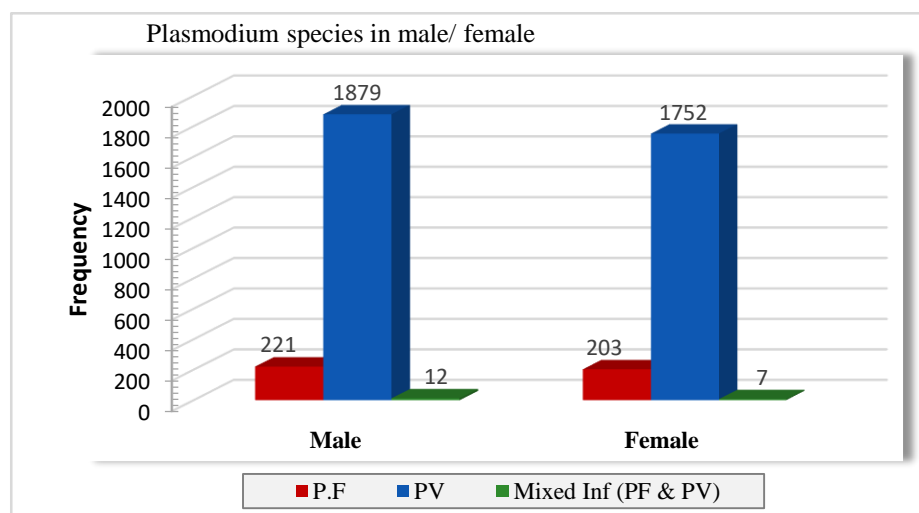


Figure 1. Plasmodium Species in Male & Female (District Kech)

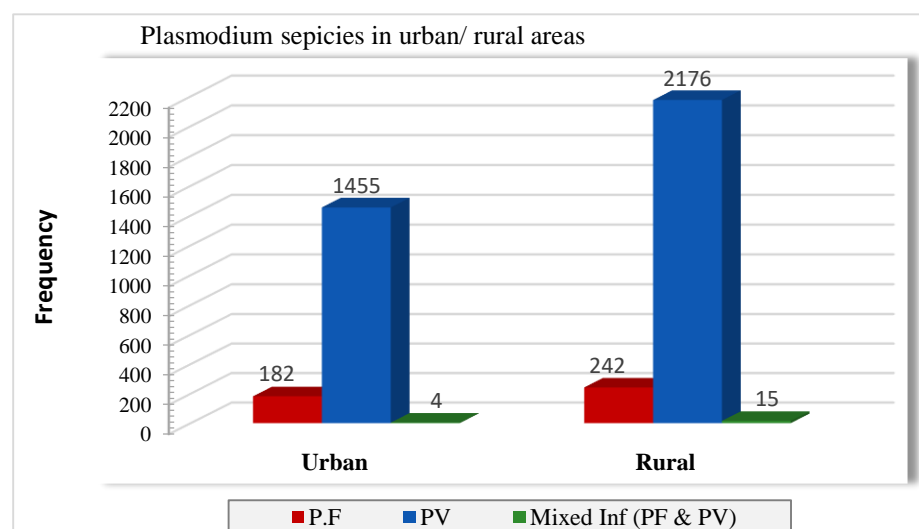


Figure 2. Plasmodium Species in Urban & Rural areas (District Kech)

Table 2: Malaria Infection Incidence Age-wise (District Kech)

Serial no.	Month	Total no. Slides Studies	Malaria Species	Total	1-5 years old	6-20 years old	21-35 years old	36-50 years old	50+ years old
01.	June 2021	3946	<i>P. Falciparum</i>	13	1	7	4	1	0
			<i>P. Vivax</i>	198	26	66	42	36	28
			<i>Mixed Infection</i>	3	1	1	0	0	1
			Total	214	28	74	46	37	29
02.	July 2021	3937	<i>P. Falciparum</i>	7	1	2	3	0	1
			<i>P. Vivax</i>	138	21	28	42	37	10
			<i>Mixed Infection</i>	0	0	0	0	0	0
			Total	145	22	30	45	37	11
03.	Aug 2021	5132	<i>P. Falciparum</i>	34	3	11	9	7	4
			<i>P. Vivax</i>	593	59	165	138	135	96
			<i>Mixed Infection</i>	2	0	1	1	0	0
			Total	629	62	177	148	142	100
04.	Sept 2021	7293	<i>P. Falciparum</i>	42	4	9	16	11	2
			<i>P. Vivax</i>	1221	92	306	318	361	144
			<i>Mixed Infection</i>	1	0	0	1	0	0
			Total	1264	96	315	335	372	146
05.	Oct 2021	6448	<i>P. Falciparum</i>	53	5	17	9	12	10
			<i>P. Vivax</i>	559	48	196	100	104	111
			<i>Mixed Infection</i>	2	0	1	0	0	1
			Total	614	53	214	109	116	122
06.	Nov 2021	7419	<i>P. Falciparum</i>	68	7	23	11	8	19
			<i>P. Vivax</i>	263	24	97	44	49	49
			<i>Mixed Infection</i>	3	0	1	1	0	1
			Total	334	31	121	56	57	69
07.	Dec 2021	4561	<i>P. Falciparum</i>	18	3	6	1	5	3
			<i>P. Vivax</i>	145	4	65	24	27	25
			<i>Mixed Infection</i>	4	0	2	1	1	0
			Total	167	7	73	26	33	28
08.	Jan 2022	2320	<i>P. Falciparum</i>	12	2	4	3	1	2
			<i>P. Vivax</i>	55	6	28	9	5	7
			<i>Mixed Infection</i>	1	0	1	0	0	0
			Total	68	8	33	12	6	9
09.	Feb 2022	1700	<i>P. Falciparum</i>	12	1	5	3	0	3
			<i>P. Vivax</i>	73	1	30	23	4	15
			<i>Mixed Infection</i>	0	0	0	0	0	0
			Total	85	2	35	26	4	18
10.	Mar 2022	1858	<i>P. Falciparum</i>	11	0	7	2	0	2
			<i>P. Vivax</i>	55	3	23	15	6	8
			<i>Mixed Infection</i>	1	0	0	0	0	1
			Total	67	3	30	17	6	11
11.	April 2022	4590	<i>P. Falciparum</i>	61	2	13	19	12	15
			<i>P. Vivax</i>	190	22	46	48	31	43
			<i>Mixed Infection</i>	0	0	0	0	0	0
			Total	251	24	59	67	43	58

12.	May 2022	3875	<i>P. Falciparum</i>	93	1	31	24	15	22
			<i>P. Vivax</i>	141	8	42	45	24	22
			<i>Mixed Infection</i>	2	0	0	1	1	0
			Total	236	9	73	70	40	44
Total:		53079	4074	345	1234	957	893	645	
Percentage			7.68%	8.69%	30.29%	23.49%	21.91%	15.83%	

The *Plasmodium Vivax* (*P.V*) was higher considerably with 89.13% (3631) than *Plasmodium Falciparum* (*P.F*) possessing 10.40 % (424) and *Mixed Infection* (*Plasmodium Vivax* & *Plasmodium Falciparum*) with 0.47% (19) among the *Plasmodium* species.

Discussion

It worth mentioning that 53079 subjects were examined principally in this study (Table 3). Notably, malaria infection is significantly higher in male (51.84%) as compare to female (48.16%) in gender. Normally, male in the district like get together and sleep in open-air and perform outdoor activities especially in rural area where the infection incidence is 59.72%, considerably higher as compare to urban 40.28%. A former research study was conducted in the same division (Makran), Panjgor district [22] which reported 38.3 percent for malaria positivity. A recent study [23] conducted in district Pishin, Balochistan that exposed higher frequency of malaria infection in male (60.4%) comparing to female (39.6%).

Furthermore, it is highly noteworthy that in the month of September the highest number of malaria infection incidence occurred with 17.33% and the second highest rate was traced in August with 12.26% on the other hand, the lowest frequency (3.6%) was taped in March. Formerly, a study conducted in Karachi and Sindh [24] documented the highest number of positive cases (19.03%) in September while lowest (3.12%) in March. One anther study [25] articulated that malaria infection prevalence increases in a great extent in Autumn season (August, September &

October) and declines frequently in Winter season. In addition, one more study [26] put into words that malaria infection was raised up in September and down in Winter season.

Further, the larger number of infected subjects were in age group 6-20 years with 30.29% and second most in 21-35 years with 23.49%. The lowest infection was found in the age group 1-5 years with 8.47%. A different study [27] conducted from two districts of Balochistan, Khuzdar and Mastung, showed the most frequent malaria infected was identified in age group 11-20 years with 26.58% and 11-20 years with 26.28% respectively. Economically, individuals in such age move to workplaces, deprived of safety standards. Significantly, incidence of *Plasmodium Vivax* was detected higher with 89.13 percent, while *Plasmodium Falciparum* possessing 10.40 percent and *Mixed Infection* with 0.47 percent, the lowest rate. In the same domain, a study was concluded in Quetta (City) Balochistan, 19.5% was positivity rate of malarial infection in which *Plasmodium Vivax* was perceived with 84.52%, *Plasmodium Falciparum* 6.01% while *Mixed Infection* 12.29% [7]. Similarly, by another study [28] in district Killa Saifullah, Blaochistan, presented 65% for *Plasmodium Vivax*, 35% for *Plasmodium Falciparum* and 1% for *Mixed Infection*, One another research study [29] exposed that *Plasmodium Vivax* incidence recorded 67%, the highest in number than other *Plasmodium* species (*Plasmodium Falciparum* 15.8% and *Mixed Infection* 17%) in district Khuzdar, Balochistan.

Table 3. Malaria prevalence & species incidence summary (District Kech)

No. of slides studied	Total Positive Cases	Positivity frequency															
		Gender		Age Groups				Locality		Species		Hospitals/ Laboratories					
		Male	Female	1-5 years	6-20 years	21-35 years	36-50 years	Above 50 years	Urban	Rural	<i>P. Falciparum</i>	<i>P. Vivax</i>	Mix Infection	Teaching Hospital (Laboratory) Turbat	Baloch Hospital (Laboratory) Turbat	Turbat Medical Center (Laboratory) Turbat	Kech (Laboratory) Medical Center Turbat
53079	4074 (7.68%)	2112 (51.84 %)	1962 (48.16 %)	345 (8.69 %)	1234 (30.29 %)	957 (23.49 %)	893 (21.91 %)	645 (15.83 %)	1641 (40.28 %)	2433 (59.72 %)	424 (10.41 %)	3629 (89.09%)	19 (0.47 %)	1090 (26.75 %)	1315 (32.28 %)	851 (20.89 %)	818 (20.08 %)

Conclusion

The findings of the study indicate, malaria is prevailing highly in rural area and moderately in urban area of district Kech (Turbat), Balochistan. Further, reveals that the male are more infected in comparison with female, the results also expose that 6-20 years (age group) stratified the highest infection rate and 1-5 years age group was measured, possessing lowest incidence rate of *Plasmodium*. Findings explored the highest number of malaria infection were recorded in September while the least in March and *Plasmodium Vivax* was experienced the most dominant parasite among the *Plasmodium* species in the district. Consequently, this research study calls attentions for controlling the endemicity of malaria infection in the district.

Authors' contributions

Conceived and designed the experiments: NI Baloch, Laboratory Experiments: NI Baloch & MI Yasinzi, Data Collection: NI Baloch, G Shaheen & B Bibi, Analysis of Data: NI Baloch, Supervision: MI Yasinzi, Paper writing: NI Baloch.

References

- Siwal N, Singh US, Dash M, Kar S, Rani S, Rawal C, & Das A (2018). Malaria diagnosis by PCR revealed differential distribution of mono and mixed species

infections by *Plasmodium falciparum* and *P. vivax* in India. *PLoS One* 13(3).

- Ayele DG, Zewotir TT, & Mwambi HG (2012). Prevalence and risk factors of malaria in Ethiopia. *Malaria J* 11(1): 1-9.
- Garg KC., Kumar S, Madhavi Y, Bahl M, Gate, & Pusa DK (2009). Bibliometrics of global malaria vaccine research. *Health Infor & Libraries J* 26(1): 22-31.
- Walther B, & Walther M (2007). What does it take to control malaria. *Ann of Trop Med & Parasitol* 101(8): 657-672.
- Pattanayak S, Dickinson K, Corey C, Murray B, Sills E, & Kramer R (2006). Deforestation, malaria, and poverty: a call for transdisciplinary research to support the design of cross-sectoral policies. *Sustainability: Sci, Prac and Pol* 2(2): 45-56.
- Worrall E, Basu S, & Hanson K (2005). Is malaria a disease of poverty? A review of the literature. *Trop Med & Inter Health* 10(10): 1047-1059.
- Sumbal A, Khan N, Naseem M, Yasinzi MI, Ara T, Arif S, Z-E-H, & Umer NJ (2020). Prevalence of pediatric malaria in Quetta (City) Balochistan, Pakistan. *Inter J of Entomol Res* 5(4): 20-23.
- Ullah I, Shams S, Ulla I, Wali H, Rishma, Nawaz M, & Afridi SG. (2019). The Incidence of Malaria in Human Population of Shergarh District Mardan Pakistan. *Biomed J of Sci & Tech Res* 18(5): 13881-13884.

9. Klein SL, Shann F, Moss WJ, Benn CS., & Aaby P (2016). RTS,S Malaria Vaccine and Increased Mortality in Girls. *MBiol* 7(2): e00514-16.
10. Maheshwari N, Shaikh M, Chand R, Maheshwari H, & Yasir M (2020). Malarial Hepatopathy in Children Visiting a Tertiary Healthcare Hospital in Karachi. *Cureus* 12(1): e6696.
11. Khan N, Sumbal A, & Ara T (2020). Malarial Prevalence in Balochistan Province, Pakistan (2002 -2020). *Inter J of Mosq Res* 7(3): 34-37.
12. Qureshi NA, Fatima H, Afzal M, Khattak AA, & Nawaz MA. (2019). Occurrence and seasonal variation of human Plasmodium infection in Punjab Province, Pakistan. *BMC Infec Dis* 19(1): 1-13.
13. Kakar Q, Khan MA & Bile KM (2010). Malaria control in Pakistan: new tools at hand but challenging epidemiological realities. *EMHJ-Eastern Mediter Health J* 16(Supp): 54-60.
14. Yasinzai MI, Kakar JK & Khel KS (2008). Incidence of human malaria infection in bordering areas adjoining with Punjab: Barkhan and Kohlu. *Pak J of Med Sci* 24: 306-310.
15. Khatoon L, Baliraine FN, Bonizzoni M, Malik SA, & Yan G (2010). Genetic structure of Plasmodium vivax and Plasmodium falciparum in the Bannu district of Pakistan. *Malaria J* 9(1): 1-10.
16. Mehdi T, Ekbal DM, Mustafa T, Chaudhry R, Butt S, Hoat A, & Tariq S (2009, December). Profile of district Kech with focus on livelihood related issues. Lahore, Pakistan: South Asia Partnership-Pakistan.
17. Kakar A (2017). District Profile Kech. (RSPN),(BRSP), (NRSP).
18. Paniker CJ (2007). Textbook of Medical Parasitology 6 Ed. Jaypee Brothers Medical Publishers (P) Ltd; New Delhi (India).
19. Manson Bahr PC, Bell DR. & Manson's (1987). Tropical Diseases 19 Ed. English language book society/Baillie's Tindall, London.
20. Chiodini PL, Moody AH, & Manser DW (2001). Atlas of medical helminthology and protozoology 4 Ed. Churchill Livingstone.
21. Neil WA (1982). introductory statistics. 4 Ed. Addison Wesley publishing company Inc.
22. Yasinzai MI, & Kakarsulemankhel JK (2013). Prevalence of human malaria infection in Pakistani areas bordering with Iran 63(3): 313-316.
23. Farooq M, Yasinzai MI, Sumbal A, Khan N, & Aziz SB (2020). Epidemiological study on malarial infection in district Pishin Balochistan, Pakistan. *Inter J of Mosq Res* 7(3): 55-58.
24. Khattak AA, Venkatesan MF, Satti HS, Yaqoob A, & Strauss K (2013). Prevalence and distribution of humanplasmodium infection in Pakistan. *Malaria J* 12: 297.
25. Zeb J, Khan MS, Ullah N, Ullah H, Nabi G, & Aziz T (2015). Epidemiology of Plasmodium species and prevalence of malaria on the basis of age, sex, area, seasonality and clinical manifestation in population of District Lower Dir, Khyber Pakhtunkhwa, Pakistan. *World J of Zool* 10(2): 147-152.
26. Farooq A, Qayyum A, Haleem A, & Ghaffar A (2009). Hematological Abnormalities in Malaria. *Biomedica* 25(1): 52-55.
27. Yasinzai MI & Kakarsulemankhel JK (2007). Incidence of human malaria infection in central areas of Balochistan: Mastung and Khuzdar. *Rawal Med J* 32: 176-8.
28. Umer NJ, & Yasinzai MI (2017). Prevalence of malaria in human population of district KillaSaifullah: Balochistan. *Pure and Appl Biol* 6(4): 1335-1339.
29. Kurd S, Yasinzai MI, Naseem M, Khan N, Sumbal A, & Ara T (2019). Prevalence of human malarial infection in school going children of district Khuzdar (city), Balochistan. *Inter J of Mosq Res* 6(6): 120-123.