

Research Article

Clinical burden of *Plasmodium falciparum* and *Plasmodium vivax* in Quetta (City)

Bushra Bibi^{1*}, Muhammad Iqbal Yasinzai¹, Ghulam Dastagir¹, Ghazala Shaheen² and Naheeda Ibrahim Baloch¹

1. Department of Zoology, University of Balochistan, Quetta, Balochistan, Pakistan

2. Govt. Girls Inter College Kirdgap, District Mastung, Balochistan, Pakistan

*Corresponding author's email: armishkhan464@gmail.com

Citation

Bushra Bibi, Muhammad Iqbal Yasinzai, Ghulam Dastagir, Ghazala Shaheen and Naheeda Ibrahim Baloch. Clinical burden of *Plasmodium falciparum* and *Plasmodium vivax* in Quetta (City). Pure and Applied Biology. Vol. 12, Issue 1, pp508-516. <http://dx.doi.org/10.19045/bspab.2023.120052>

Received: 30/09/2022

Revised: 09/11/2022

Accepted: 18/11/2022

Online First: 30/11/2022

Abstract

Undoubtedly, the contemporary world has developed a lot with uncountable advancements in numerous fields; however, malaria still proves to be a grave threat. Not so much work has been produced for the spatiotemporal malarial analysis as well as its spread. Similar scenario can be seen in Pakistan and Quetta presents no different situation. This research work is carried out to observe the present day scenario of malarial infection in the general population of Quetta (city) and to aware the masses of the deadly risks related to malarial infection, its causes and to instruct them of the control and preventive measures to minimize its spread. Moreover, the up-to-date data can be helpful for the upcoming researches. The study was conducted for a net duration of 12 months w-e-f January 2020 to December 2020 taking into account all the seasonal variations. Several check-points such as schools, hospitals, laboratories, BHUs were visited religiously i.e. twice a month. An aggregate of 2679 samples were collected. Thereafter; thick as well as thin slides were made. From the data gathered from all the above-mentioned areas, the overall occurrence of malaria positive slides was 654 with 24.4 %. *Plasmodium vivax* was found in an abundant ratio i.e. 623 (95.2%) compared to *Plasmodium falciparum* 09 (1.3%). However, 22 (3.36%) cases were due to mixed infections. During the entire research study, Sabzal road and Pashtoonabad areas presented the highest prevalence rate 72 (30%) and 70 (29.7%) respectively, whereas the results from the area of Airport road presented the lowest occurrence 22 (15.8%). *Plasmodium vivax* was seen dominant with highest incidence 70 (97.2%) with an overall gender-wise result of 388: 266 found prevalent in males 59.3% than in females i.e. 40.6%

Keywords: *Plasmodium falciparum*; *Plasmodium vivax*; Quetta

Introduction

Balochistan; an un-ignorable and largest province, lies in the south-western corner of the country, Pakistan. It fills up an area of 347,190 km² or 134,050 mi² adding up to 44% of land area of the country, Pakistan. Quetta, the famous fruit garden of Pakistan is not only the provincial capital but also

Balochistan's largest city. It consists of districts Quetta, Pishin, Qilla Abdullah, Chaghi and Noshki. In Quetta city, high population density, unhygienic condition in different residential areas, poor dumping system of wastes, reduced literacy rate and lack of basic living facilities, agricultural practices with substantial irrigation system,

heavy rains and movement inside or across the borders are some of the factors contributing to break out of malaria [1]. Females, as compared to males are at a lower risk of acquiring malarial infection due to less exposure to the outside world [2].

Malaria, undoubtedly, is a life-and-death issue caused by a minute parasite of the genus *Plasmodium*. The malarial parasite depends on two hosts for the completion of its life cycle i.e. Human and female *Anopheles* [3]. Transmission is also through the above mentioned mosquito vector. The word Malaria is of Italian origin “*mala*” meaning bad and “*aria*” symbolizes air. So, the literal meaning of malaria is “polluted air” or “contaminated air”. The malaria infected person usually suffers from febrility, sickness and shivering along with flu, vomiting and exhaustion [4]. There is an abundance of four *Plasmodium* species on a global scale which are notoriously known for causing a widespread infection. These include *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale* and the deadly *Plasmodium malariae*. *Plasmodium knowlesi*, is an important specie which has been reported in several countries except Pakistan. There are convenient ways of malarial diagnosis that i.e. By the use of light microscopic examination of blood films, antigen based standard diagnostic testing system etc [2, 5, 6]. Besides, few other methods for malaria diagnosis are; Rapid Diagnostic Testing (RDTs), Polymerase Chain Reaction and loop-mediated isothermal amplification process [7].

Malaria is found to be a local threat to about 100 countries ranking as a second-most regularly observed disease in third world countries [8]. Despite the fact that it is curable, Pakistan is one of the malarial-stricken countries with a net report of 96% clinical cases [9]. Approximately 60% of the population of Pakistan, up to the present time reside in malarial-prone urban and rural

areas. Malaria exists chiefly in Balochistan province, Khyber Pakhtunkhwa Sindh as well as FATA. Cerebral malaria serves as a serious threat in Balochistan.

With a noteworthy transmission in Balochistan, a higher transmission rate of *Plasmodium vivax* starts in June and ends in September and also recurs from April to June. Moreover, infection reappearance can be noted in December also. In Pakistan, children under the age of 10 years are found to be prone to malarial infection along with the pregnant women with the visible symptoms during the months of August to September [2, 10]. *Plasmodium falciparum* and *Plasmodium vivax* are the two species which are considerably predominant in Pakistan. The season that is best for the transmission of *Plasmodium falciparum* is from the month of August to the month of December whereas *Plasmodium vivax* shows peak levels of transmission from the month of June to September with recurrence w-e-f April to June [11]. Annually, over 15% malarial infection result in about 600,000 deaths. This deadly infection brings about 400,000 deaths of children globally, especially under the age of five years are more prone to be attacked by this infection. According to the Global Annual Report on malaria, almost 219 million cases with 4, 35,000 deaths were reported solely in the year 2017. Among them, African region data provided 92% deaths and South-East Asian countries stood at a percentage of 5 [12].

Multiple studies previously have been conducted for the analysis of the general attitudes of the locals towards malarial infection along with the practices involved. However, the current study aimed to find out the occurrence of malarial parasites in the general population of Quetta (city).

Material and Methods

Research design

This investigation study was conducted throughout the annum w-e-f January 2020 to

December 2020 in order to spot and study malaria incidence in the general population of Quetta (City). In order to study the prevalence of *Plasmodium falciparum* and *Plasmodium vivax*, the blood slides were collected from multiple localities such as laboratories, hospitals including civil hospital, Bolan Medical college hospital Quetta, schools, homes etc. from 10 January 2020 to 20 December 2020. Both Passive Case Detection and Active Case Detection methods were used for the collection of data. Thick as well as thin blood marks slides were prepared twice in every single month from the respective institution. The slides were prepared by the methods devised by [13-16]. Patients were categorized into numerous groups; Age, Area and Gender-wise. The common symptoms observed were febrility, sickness and shivering along with flu, vomiting and exhaustion. Approximately 13 different localities were visited religiously. Affectees were categorized into four major groups, 1-15, 16-30 and 31-45 and 46 -60 years of age. A net of 2679 smears were made twice or thrice a month.

Data collection and variables of the study

The malarial infection cases were identified and confirmed by picking the keys presented by [17]. Visits to all the above mentioned localities were made twice monthly as well as seasonally. Additionally, the samples were tested for the possible presence or absence of malarial parasites. During these visits, the

protozoal contagion slides were formed by the assistance of the heads of the healthcare institutions. Afterwards, Thick and thin slides were prepared which, later were transferred to the Zoology Department of University of Balochistan for further detailed examination.

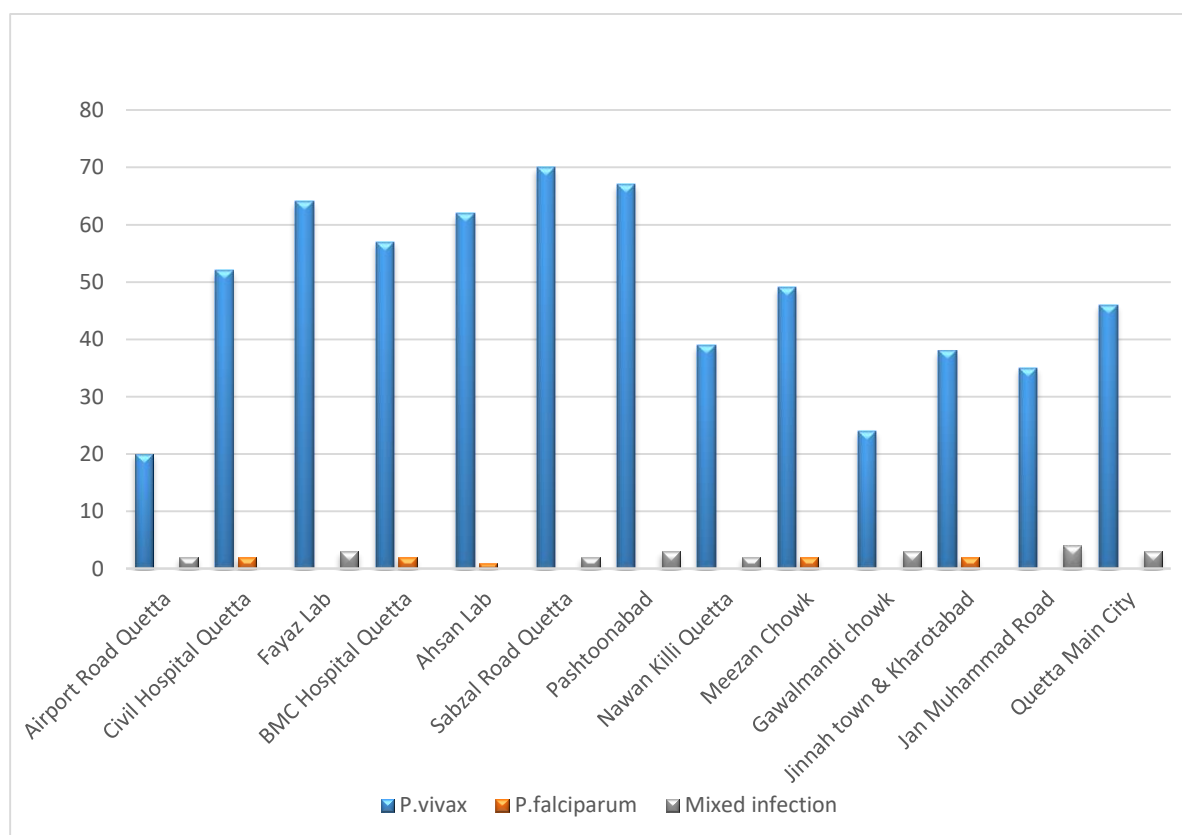
Results

An aggregate of 2679 slides of both sexes; male and female were collected from various localities of Quetta (City) with specialized age groups such as 1 to 15 years, 16 to 30 years, 31 to 45 years and 46 to 60 years. The concerned localities under research study exhibited frequency of positivity as 24.4% *Plasmodium vivax* was found dominant with a notable percentage that was 95.2% as opposed to *Plasmodium falciparum* which exhibited 1.3% whereas mixed infections stood at a percentage of 3.3%. Area-wise the most prevalent species was *Plasmodium vivax* 30% in Sabzal Road Quetta oppositely the least incidence noted from Airport Road Quetta was 15.8% (Table 1). Monthly incidence was once again seen elevated in *Plasmodium vivax* species especially in the month of July and least in January (Table 2). Likewise, percentage along with frequencies are shown by graphs as in (Graph 1 & 2) areas and month wise respectively whereas age and gender-wise prevalence is exhibited in (Tables 3 & 4; Graph 3 & 4) respectively. The male and female ratio was observed to be 59.3% and 40.6% respectively.

Table 1. Locality-wise current status of malaria in the general population of Quetta (City)

S. No.	Name of area	Aggregate slides studied	Total +ve slides	<i>P. vivax</i>	<i>P. falciparum</i>	Mixed infection
1	Airport Road Quetta	139	22 (15.8%)	20 (90.9%)	-	02 (10%)
2	Civil Hospital Quetta	202	54 (26.7%)	52 (96.2%)	02 (3.8%)	-
3	Fayaz Lab	245	67 (27.3%)	64 (95.5%)	-	03 (4.8%)
4	BMC Hospital Quetta	235	59 (25.1%)	57 (96.6%)	02 (3.3%)	-
5	Ahsan Lab	218	63 (28.8%)	62 (98.4%)	01 (1.5%)	-

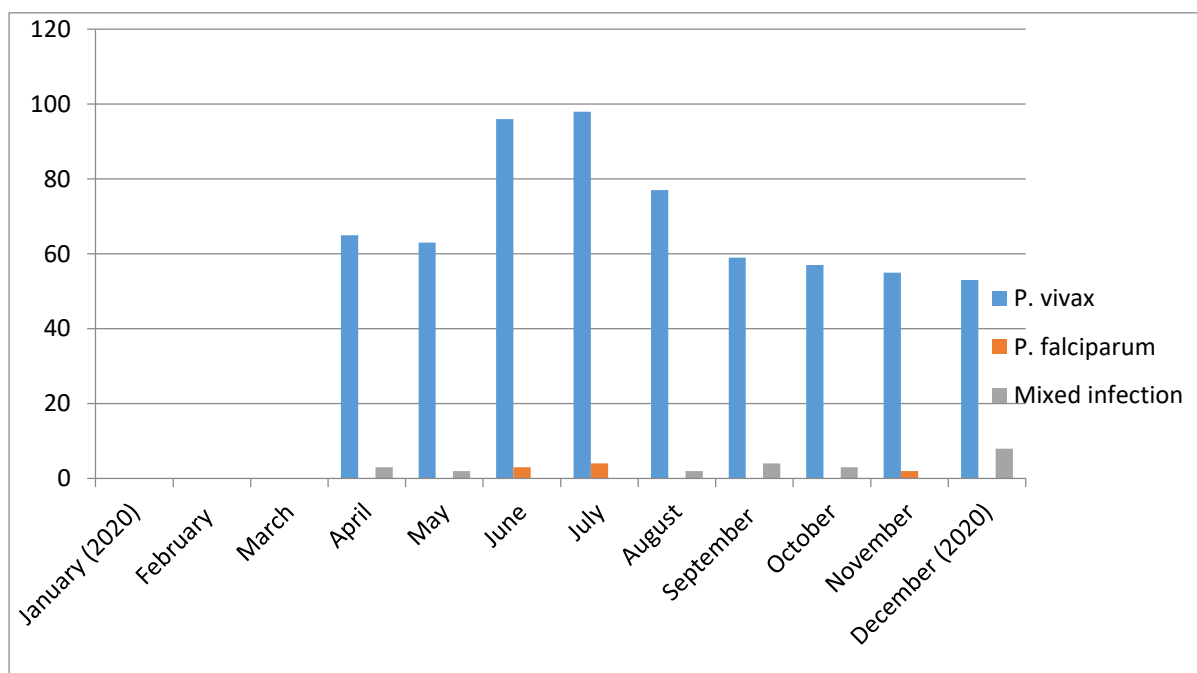
6	Sabzal Road Quetta	240	72 (30%)	70 (97.2%)	-	02 (2.8%)
7	Pashtoonabad	235	70 (29.7%)	67 (95.7%)	-	03 (4.4%)
8	Nawan Killi Quetta	173	41 (23.6%)	39 (95.1%)	-	02 (5.1%)
9	Meezan Chowk	185	51 (27.5%)	49 (96%)	02 (3.9%)	-
10	Gawalmandi chowk	101	27 (26.7%)	24 (88.8%)	-	03 (12.5%)
11	Jinnah town & Kharotabad	241	40 (16.5%)	38 (95%)	02 (5%)	-
12	Jan Muhammad Road	209	39 (18.6%)	35 (89.7%)	-	04 (11.4%)
13	Quetta Main City	256	49 (19.1%)	46 (93.8%)	-	03 (6.5%)
	Total	2679	654 (24.4%)	623 (95.2%)	09 (1.3%)	22 (3.3%)



Graph 1. Locality-wise current status of malaria in Quetta (City)

Table 2. Monthly occurrence of malarial infectivity in Quetta (city)

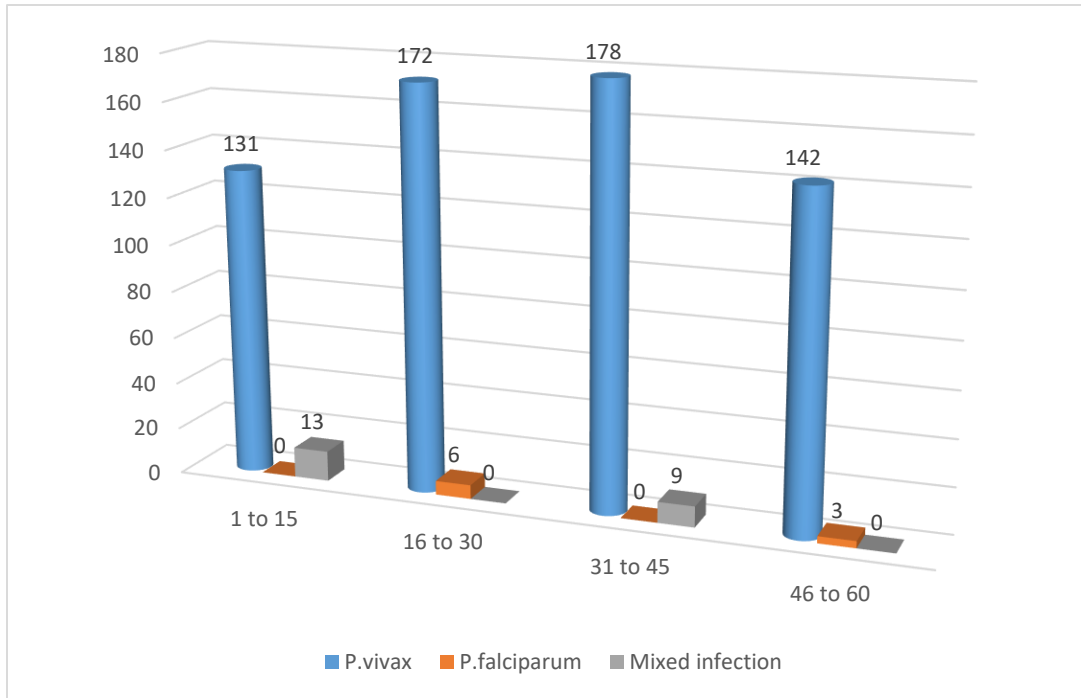
S. No.	Month	Total studied slides	+ve Slides	<i>P. vivax</i>	<i>P. falciparum</i>	Mixed infection
1	January (2020)	214	0	0	0	0
2	February	210	0	0	0	0
3	March	215	0	0	0	0
4	April	217	68	65	0	03
5	May	218	65	63	0	02
6	June	244	99	96	03	0
7	July	222	102	98	04	0
8	August	242	79	77	0	02
9	September	229	63	59	0	04
10	October	241	60	57	0	03
11	November	219	57	55	02	0
12	December (2020)	208	61	53	0	08
	Total	2679	654	623	9	22



Graph 2. Monthly occurrence of Malarial infectivity in Quetta (City)

Table 3. Age-wise recent Malarial occurrence in Quetta (City)

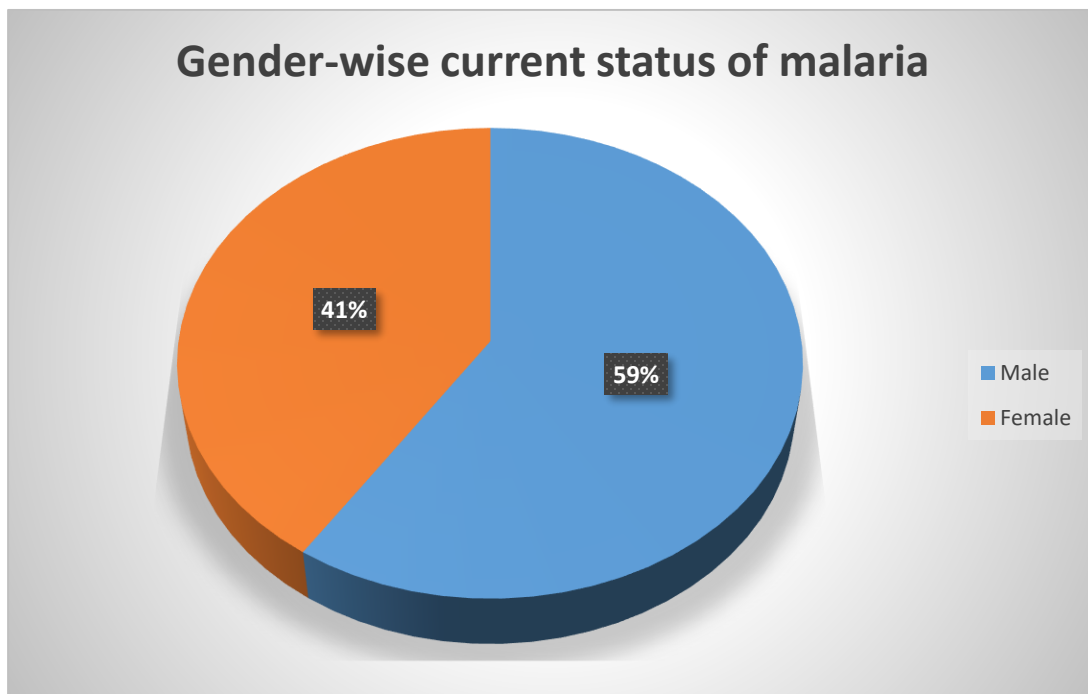
S. No.	Age groups	Net slides studied	Aggregate +ve slides	Complete %age in fraction	<i>P. vivax</i>	<i>P. falciparum</i>	Mixed infection
1	1-15	623	144	23.11%	131	-	13
2	16-30	696	178	25.57%	172	6	-
3	31-45	701	187	26.67%	178	-	9
4	46- 60	659	145	22%	142	3	-
	Total	2679	654	24.41%	623	9	22



Graph 3. Age-wise recent malaria occurrence in Quetta (City)

Table 4. Gender-wise current status of Malaria

S. No.	Aggregate slides examined	Net +ve slides	Male +ve slides studied	Female +ve Slides studied
1	2679	654 (24.4%)	388 (59.3%)	266 (40.6%)



Graph 4. Gender-wise current status of Malaria

Discussion

The prime purpose of this study was to find out the latest incidence of malarial infection in the general population of Quetta city. For this purpose, an aggregate of 2679 blood slides was studied for the possible presence of the deadly parasite after being collected from 13 different localities of the said city. Among these, 654 samples showed a positive result with a percentage of 24.4%. *Plasmodium vivax* was found the most common and dominant species over the others with 623 positive results (95.2%) contrary to *Plasmodium falciparum* which showed 9 (1.3%). However, the mixed infection was observed to be 22 (3.3%). Highest incidence (30%) was observed from Sabzal road Quetta while least was found in airport road Quetta. Gender-wise male female ratio of infectivity was 59.3% and 40.6% found elevated in males.

A similar study was conducted in Khuzdar to find out the malaria prevalence in school going children which revealed almost identical results with 27.9% positivity rate whereby *Plasmodium vivax* showed related results with dominance 67% over *Plasmodium falciparum* 15.8% [4]. Likewise, results were reported from the area of killa saifullah with 20% positivity rate with 64.7% *Plasmodium vivax* cases. Killi dolatzai *Plasmodium vivax* incidence was reported 70.5% and least in Nalisar 48.9% [18]. An investigation in KPK province exhibited much the same results with 13.8% leading the other three provinces; Punjab, Sindh and Balochistan with 2.4%, 10.8% and 3.8% respectively [11]. Approximately 200 malarial cases were studied in PAI (Pakistan Army Institute) with *Plasmodium vivax* standing at 62.5% contrary to *Plasmodium falciparum* that showed 36% [19]. A similar study reported infection incidence found to be elevated in July and at the end of August [20]. Analogous elevated incidence was reported in September and least in winter

season [21]. Another related study on school going children of city areas revealed 19.5% prevalence with 83.5% *Plasmodium vivax* and 6% *Plasmodium falciparum* cases along with 12.2% mixed infections [2]. Similar study carried out in Orakzai agency revealed the malarial prevalence due to Pakistan's socio-economic setup [22]. In another conducted research, the highest prevalence was noted in August i.e. 91.6% and least in March 57.1%. The higher incidence can be associated with the fact that during these months, standing water provides an ideal place for mosquito breeding [23]. Different other regions of Pakistan showed elevated *Plasmodium vivax* density i.e. Muzaffarabad with 90.4%, Multan with a percentage of 60.5%, Okara 98% and lastly South Punjab exhibited 12.39%. Another research study also declared *Plasmodium vivax* as prevalent in areas of Ziarat and Kohlu with 88.5% and 58.9% in Kohlu and 64.7% and 54.6% in Ziarat [24]. Similar research reported an upsurge in July and at end of the month of August. However, another finding blamed the seasonal rainfall in autumn for the constant widespread infection as it provided the optimal temperature for the breeding of mosquito [4, 20].

Conclusion

The conclusion established by this extensive study is that malarial infection that is caused due to the bite of mosquito; Anopheles and specifically due to the *Plasmodium* parasite, may be fatal. In this regard, out of 2679 slides of various age-groups, 654 showed positive results. *Plasmodium vivax* (95.2%) was found dominant over other three species during the entire research period. During the research analysis, the highest incidence was noted in the area of sabzal road, Quetta (30%) whereas least ratio was found in the area of airport road (15.8%). The mixed parasites were noted to be 3.3%. The months of July and June were seen to be an ideal time for the spread of malaria as these months exhibited

the peak values. *Plasmodium vivax* was observed to be dominant over *falciparum* in both genders. Males were found more prone to get infected as opposed to females due to a greater exposure to the outside world. Moreover, Dearth of finance, Inability of policy making, less diagnostic facilities serve as major hurdles in the malarial control as well as its spread and management in Pakistan. However, best possible measures must be taken for malarial control.

Author's contributions

Conceived and designed the experiments: MI Yasinzai, Performed laboratory experiments: B Bibi, MI Yasinzai & G Dastagir, Data Collection: B Bibi, G Shaheen & N Ibrahim, Data analysis: B Bibi, Paper Writing: B Bibi.

References

1. Najeeb UK *et al.* (2018). Incidence of Malaria in Khyber Pakhtunkhwa Pakistan – A Meta-Analysis. *Ann Rev Res* 3(4): 555-619.
2. Sumbal A *et al.* (2018). Frequency of *Plasmodium vivax* and *Plasmodium falciparum* malaria in school going children of Quetta (City), Balochistan. *Inter J of Biosci* 13(6): 43-50.
3. Hundessa SH *et al.* (2016). Spatial and space-time distribution of *Plasmodium vivax* and *Plasmodium falciparum* malaria in china, 2005-2014. *Malaria J* 15: 595.
4. Kurd S *et al.* (2019). Prevalence of human malaria infection in school going children of district Khuzdar (city), Balochistan. *Inter J of Mosquito Res* 6(6): 120-123.
5. Augusto FB, Delvalle sy, Blayneh kw, Ngonfhala CN, Goncalves MJ & *et al.* (2013). The impact of bed-net malaria prevalence. *J theor Biol* 320: 58-65.
6. Carter KH, Escalada RP & Singh P (2017). Malaria in arthropod borne diseases Bern city: *Springer Inter Pub.* pp. 325-346.
7. Sitali L *et al.* (2019). Distribution of *Plasmodium* species and assessment of performance of diagnostic tools used during a malaria survey in Southern and Western Provinces of Zambia. *Malaria J* 18: 130.
8. Herricks JR, Hotez PJ, Wanga V, Coffeng LE Hagsma JA, Basanez MG, Budkie G & *et al.* (2017). The global Burden of disease study 2013: What does For the NTDs. *Plos Negl trop Dis* 11(8): ll, e0005424.
9. Ahmad T, Ullah A, Sherwani SK & Neelam (2014). Knowledge Attitude and Practices of School going children towards Malaria. *World Appl Sci J* 31(4).
10. Pakistan Medical Research Council 2013-14 (2014.). Malaria Indicator Survey in 38 High Risk Districts of Pakistan.
11. Khattak AA, Venkatesan MF, Satti HS, Yaqoob A, Strauss K & *et al.* (2013). Prevalence and distribution of human *Plasmodium* infection in Pakistan. *Malaria J* 12: 297.
12. World Health Organization, World Malaria Report, 2019.
13. Paniker, CKJ (2002). *Text Book of Medical Parasitology, 5th Ed Japee Brothers, and Medical publishers (P) Ltd New Delhi.* pp. 61-88.
14. Cheng TC (1986). *General Parasitology, 2nd Ed.* Academic Press, Collage Division New York 1-787.
15. Sood R (1989). *Haematology, 3rd Ed,* Japee Brothers, Med. Publishers (P), Ltd, New Delhi, India.
16. Chiodini PI, Moody AH & Manser DW (2001). *Atlas Medical Helminthology and paleontology, 4th Ed,* Churchill, Livingstone, Edinburgh, London, New York.
17. Manson-bahr, PEC, & Bell (1987). *Dr. Manson's tropical disease. 19th Edition,* *English Language Book Society/ Balliere Tindall, London.*

18. Umer NJ & Yasinzi MI (2018). Variations of human malarial infection in different localities of district Killa saifullah Balochistan province. University of Sindh. *J of Ani Sci* 2(2): 12-16.
19. Jamal MM, Jehan A and Nadir A (2005). Malaria in pediatric age group: a study of 200 cases in Pakistan Armed Forces. *Med J* 55: 74-77.
20. Shahwani MN, Nisar S, Aleem A & Panezai M (2017). Amplification of Mitochondrial DNA for detection of *Plasmodium vivax* in Balochistan. *J Pak Med Assoc* 67(5).
21. Naeem A, Ahmed S & Khan A (2018). Detection of asymptomatic carriers of malaria in Kohat district of Pakistan. *Malarial J* 17: 44.
22. Karim AM, Hussain I, Malik SK, Lee JH, Cho IH, Kim YB & Lee SH (2016). Epidemiology and clinical burden of malaria in the war town area Orakzai Agency in Pakistan. *PLoS Neg Tro Dis* 10(1): e0004399.
23. Sumbal A, Khan N, Naseem M, Yasinzi MI Ara T, Arif S, Humaz & Umer NJ (2020). Prevalence of pediatric malaria in Quetta (city) Balochistan, Pakistan. *Inter J of Entomol Res* 5(4): 20-23.
24. Mabunda S, Aponte JJ, Tiago A & Alonso PA (2009). Country wide malaria Survey in Mozambique, malaria Attribution Proportion of fever and establishment of malaria case definition in children across different epidemiological Settings. *Mal J* 8(Art#74): 1-7.