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THROMBOCYTOPENIA PREVALENCE AND SEVERITY ASSESSMENT IN PLASMODIUM VIVAX MALARIA PATIENTS

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Abstract:
Background: Thrombocytopenia, characterized by reduced platelet counts, is a known consequence of various malaria infections. Nevertheless, its occurrence and clinical significance in Plasmodium vivax malaria have received limited attention. While thrombocytopenia and anemia are frequently observed abnormalities, this study aims to assess thrombocytopenia in Plasmodium vivax malaria patients, providing insights into the risk of severe thrombocytopenia.
Methodology: This descriptive cross-sectional study was carried out at Hayatabad Medical Complex in Peshawar, Pakistan. A total of 297 cases were included in the study using a consecutive non-probability sampling method. Patients of both genders between ages 18 to 60 years, with smear-positive VIVAX malaria who had a fever exceeding 100 degrees Fahrenheit for at least one day were included. Confounding factors were managed through strict adherence to exclusion criteria.
Result: Thrombocytopenia was highly prevalent among Vivax Malaria patients, affecting 82.83% of cases, with 17.17% remaining unaffected. Most patients experienced mild or moderate thrombocytopenia, while severe cases were rare (1.35%). Analysis by age revealed a slight increase in older patients. Prevalence of thrombocytopenia was 80.9% for ≤30 years, 81.4% for 31-40 years,

84.5% for 41-50 years, and 89.5% for >50 years. Gender-based analysis showed a slightly higher prevalence in females (83.2%) versus males (82.6%), though not statistically significant.
Conclusion: These findings highlight the importance of monitoring platelet counts and comprehending the clinical significance of thrombocytopenia in vivax malaria management. Further research is needed to gain a comprehensive understanding of the underlying mechanisms and clinical implications of thrombocytopenia in vivax malaria.

Key Words: Anemia, Malaria, Plasmodium Vivax, Thrombocytopenia

Introduction

Malaria is a potentially life-threatening disease caused by infection with Plasmodium protozoa transmitted by an infective female Anopheles mosquito (1). The infection can develop suddenly and produce several life-threatening complications (2). It is one of the most prevalent infectious diseases in the world, with approximately 216 million cases of malaria and 655,000 deaths in 2015 recorded worldwide (3). The 5 Plasmodium species well known to cause human malaria are; P falciparum , P ovale , P vivax, P malariae, and P knowlesi (4). Among them, Plasmodium falciparum causes life-threatening complications (5). However, plasmodium vivax malaria is prevalent in many regions of the world, influencing nearly 40% of the total population. Its dormant liver stages' diagnostic invisibility may underestimate its prevalence, with cases primarily originating from southeast Asia including Pakistan at 79.13% (6) and the western Pacific, including the majority of cases in Pakistan (7,8).

Malaria patients typically exhibit symptoms such as headache, cough, fatigue, malaise, shaking chills, arthralgia, and myalgia, with variable incubation periods influenced by host immunity and Plasmodium species (9). Particularly, P. vivax infections cause undifferentiated fever, anemia (occasionally complicated by thrombocytopenia), splenomegaly, and severe malaria (in rare cases), with considerable adverse effects on well-being and socioeconomic development (10). P. vivax malaria is a significant public health concern that continues to claim the lives of more than 435,000 people each year. To reduce malaria impact, early diagnosis and effective treatment are crucial (2,11). There are RDTs available that detect P vivax in endemic countries but have limitations in sensitivity and distinguishing mixed infections. Microscopy is effective when performed by skilled technicians but is challenging in resource-poor areas. Advanced methods like polymerase chain reaction (PCR) and loop-mediated isothermal amplification (LAMP) have begun to be widely used in research and diagnosis of malaria (12–14). The emergence of antimalarial drug resistance complicates current global efforts to eliminate malaria (15). Chloroquine resistance in P. vivax was first reported in 1989 and is now found in multiple countries. Dihydroartemisinin-piperaquine or artemether-lumefantrine is used in resistant areas. Primaquine treats hypnozoites but may cause hemolysis in G6PD-deficient individuals, common in endemic regions, necessitating G6PD testing, especially in children (12).

Thrombocytopenia is a well-recognized complication of malaria due to P. falciparum and vivax (16). Studies have shown that platelets are an important component of the host's innate immune responses against malaria infection (8). Thrombocytopenia (platelet count < 150 000/mm3) seems, by all accounts, to be an extremely visible hematological alteration in acute malaria infection (7). In spite of the fact that thrombocytopenia is excluded from the present World Health Organization (WHO) criteria for characterizing extreme Plasmodium vivax malaria, its clinical significance has been generally perceived. Numerous studies and case reports have shown that severe thrombocytopenia was described as the most important severity sign of vivax malaria. For example, a review investigation on 614 patients has demonstrated that multi-organ dysfunction (MOD) and resulting danger of death were found in patients with thrombocytopenia with vivax malaria. Thrombocytopenia is linked to various Plasmodium infections, but the relationship between platelet count and parasitemia is inconclusive in the literature (17)(18). There has been a recent increase in local studies in the literature that have assessed the frequency of thrombocytopenia in Plasmodium vivax infection in different geographic locations; 69% (19), and 55% (20).

In order to understand the occurrence and role of thrombocytopenia in plasmodium vivax malaria in our community and improve clinical practice guidelines, this study will quantify thrombocytopenia in plasmodium vivax malaria patients and will also establish the associated relative risks of severe thrombocytopenia in patients with Plasmodium vivax malaria. The study will also become a base for further research.

Material and Methods

This descriptive cross-sectional study was conducted with the ethical approval of Institute of Paramedical Sciences. The study was carried out at Hayatabad Medical Complex in Peshawar, Pakistan, from November 8, 2023, to April 5, 2024. A total of 297 cases were included in the study using a consecutive non-probability sampling method. Informed written consent was obtained from all eligible patients. This study included all those patients who were between 18 to 60 years, both male and female, with smear-positive VIVAX malaria who had a fever exceeding 100 degrees Fahrenheit for at least one day. Exclusion criteria were carefully applied to ensure the study's integrity, excluding patients treated outside the hospital for malaria, those lacking pre-treatment platelet count data, individuals with chronic renal failure, and those with concurrent illnesses that could induce thrombocytopenia, or who were taking specific medications. These exclusion criteria aimed to minimize potential confounding factors and bias in the study's results.

A 5 mL blood sample was collected in EDTA tubes from each patient via venipuncture for thrombocytopenia detection. Detailed patient histories and clinical examinations were conducted. Thick and thin blood smears were prepared from the blood samples, and examined by a consultant pathologist to detect plasmodium vivax. Additionally, patients underwent blood sugar level tests, liver and renal function assessments, and chest X-rays. G6PD level evaluations and HIV testing. Prothrombin time and activated partial thromboplastin time tests were performed for patients with thrombocytopenia, and Arterial blood gas analysis was conducted when clinically indicated. Platelet counts were determined by the same person who identified malarial parasites in the smears, ensuring consistent laboratory standards. Thrombocytopenia severity was graded according to predefined criteria. The study assessed the frequency and severity of thrombocytopenia among the total cases, with data presented in charts and tables Confounding factors were managed through strict adherence to exclusion criteria.

Data were stored and analyzed by statistical software SPSS version 17. All the quantitative variables like age, platelets count and disease duration were analyzed by Mean, +/- standard deviation. Frequencies and percentages were calculated for qualitative variables like sex, thrombocytopenia and its severity. Thrombocytopenia and its severity were stratified among age, gender, and platelet count to see effect modifications. Effect modifiers like anemia were controlled through stratification. Post-stratification chi-square test was applied to keep the P value equal to or less than 0.05. All the results were presented in tables and graphs.

Result

In this study, a total of 297 patients diagnosed with slide-positive Vivax Malaria and presenting with febrile illness were included. Among these patients, 178 (59.93%) were males, and 119 (40.07%) were females, resulting in a male-to-female ratio of 1.46:1. The average age of the patients was 34.28 years, with a standard deviation of 12.44, and their ages ranged from 18 to 60 years. Patients were categorized into four age groups, with the most common group being those aged 30 years or younger, comprising 44.1% of the total. The study also found 23.6% of patients aged 31-40 years, 19.5% aged 41-50 years, and 12.8% aged over 50 years which can be seen in **Table 1**.

Table 1 Gender and Age wise distribution of patients with Plasmodium Vivax Malaria

Age and Gender	Categories	Thrombocytopenia (Yes)	Thrombocytopenia (No)
Gender	Male	147 (82.6%)	31 (17.4%)
	Female	99 (83.2%)	20 (16.8%)
Age in Years	≤30	106 (80.9%)	25 (19.1%)
	31 - 40	57 (81.4%)	13 (18.6%)
	41 - 50	49 (84.5%)	9 (15.5%)
	51+	34 (89.5%)	4 (10.5%)

Thrombocytopenia was a prevalent condition among these Vivax Malaria patients, affecting 82.83% of them, while 17.17% did not exhibit thrombocytopenia. The severity of thrombocytopenia varied, with the majority of patients experiencing mild or moderate thrombocytopenia, and only a small proportion (1.35%) suffering from severe thrombocytopenia as depicted in **Fig 1 and Fig 2**. Age-wise analysis revealed that thrombocytopenia was distributed across different age groups, with older patients having a slightly higher incidence. Patients aged less than or equal to 30 years had an 80.9% prevalence of thrombocytopenia, while those aged 31-40 years showed 81.4%, those aged 41-50 years had 84.5%, and patients over 50 years old exhibited the highest Incidence at 89.

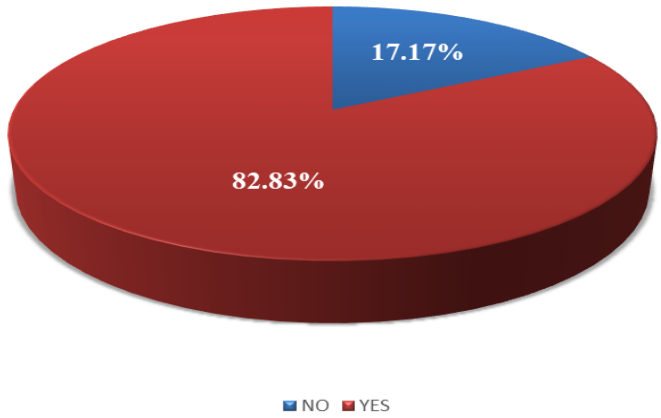

Fig 1 Thrombocytopenia in Plasmodium Vivax Malaria Patients

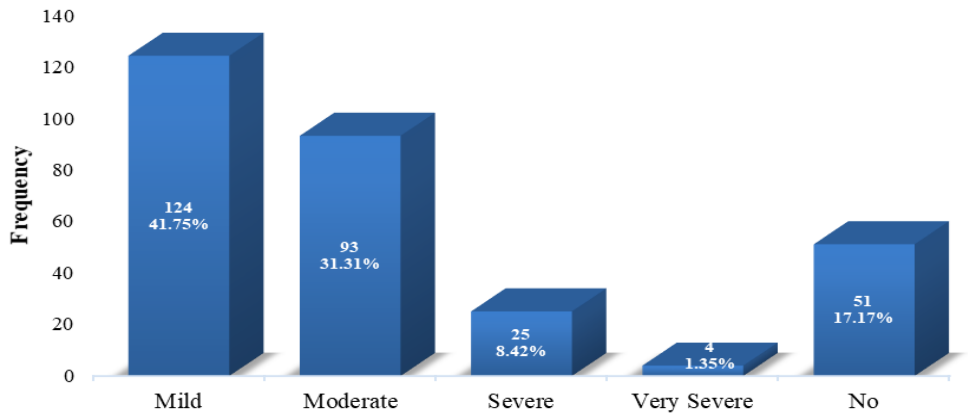

Figure 1 Classification of thrombocytopenia reported in plasmodium vivax patients

The study also investigated gender-based differences in thrombocytopenia and found that while there was a slightly higher prevalence of thrombocytopenia among female patients (83.2%) compared to males (82.6%), the difference was not statistically significant. Moreover, the research examined the relationship between thrombocytopenia and the duration of the disease, and the presence of anemia, which yielded similar results. These findings suggest that thrombocytopenia is a common complication in Vivax Malaria patients and that its occurrence is largely independent of age, gender, disease duration, or anemia status as shown in **Table 2**.

Table 2: Disease duration and Anemia distribution of Thrombocytopenia in slide-positive Vivax malaria

Parameter	Status/Duration	Thrombocytopenia (Yes)	Thrombocytopenia (No)	p-value
Anemia	Yes	130 (83.9%)	25(16.1%)	0.619
	No	116 (81.7%)	26 (18.3%)	
Duration of Disease (Days)	≤ 3	92 (87.6%)	13 (12.4%)	0.105
	> 3	154(80.2%)	38 (19.8%)	

Discussion

Malaria is the most widespread public health problem in the tropics among blood infections. Plasmodium vivax malaria, also known as benign tertian malaria, is a tropical disease with a global distribution. The incidence of malaria is estimated at 1.5 million cases annually of which nearly 40% are due to P. vivax (21). Males were more affected than females in our study. This male predominance was also evident in other studies conducted locally and abroad like Peshawar (22), Jamshoro (23), Abbottabad (21), Karachi (1), Quetta (30), Ethiopia (2), Papua New Guinea (31), and Saudi Arabia (24), Nepal (25), India (26). In this study there was no sex restriction, so we had both male and female patients who presented to us with P. vivax. There were 178(59.93%) males and 119(40.07%) females. Male to female ratio was 1.46:1.

Since the beginning of the 1970s, there have been reports proposing that malaria-associated thrombocytopenia is quite similar in P. vivax and Plasmodium falciparum infections (27). However, more recent data in India has shown how thrombocytopenia exhibited a heightened frequency and severity among patients with P. vivax infection (28). The presence of thrombocytopenia in acute febrile travelers returning from tropical areas has become a highly sensitive clinical marker for malaria diagnosis (29). Another study has reported 60% sensitivity and 88% specificity of thrombocytopenia for malaria diagnosis in acute febrile patients (30). The sensitivity of thrombocytopenia together with the acute febrile syndrome was 100% for malaria diagnosis, with a specificity of 70%, a positive predictive value of 86%, and a negative predictive value of 100%.

Thrombocytopenia was one of the key laboratory findings in this study found in 82.83% of patients suffering from vivax malaria. Similar results are documented by studies conducted by other researchers. A recent study conducted in India reported thrombocytopenia was seen in 80% of patients. More than one-third of patients (40.0%) had moderate thrombocytopenia followed by mild (36.2%) and severe (23.8%) (22), another study from Ethiopia observed about 67% of malaria-infected patients had mild to moderate thrombocytopenia and 12.3% had severe thrombocytopenia (31). Mohd Arif et al in their paper mentioned the diagnostic significance of thrombocytopenia and the Incidence of thrombocytopenia was 79%, out of which mild, moderate, and severe degrees of thrombocytopenia was seen at 35.44%, 41.77%, and 22.78% respectively (16).

Anemia was another hematological indicator, which was seen in 52.2% of patients. As most of the patient's previous reports of hemoglobin (Hb) were not available, it was difficult to ascertain whether anemia was due to malaria or some other disease like worm infestation, acid peptic disease, or nutritional deficiency-related anemia. A varying degree of anemia was also seen in the study by Samantha Soares et al (32). An emergency case of P.vivax malaria of a 37-year-old Pakistani patient

in Italy showed hemoglobin, 15.9 g/dL; red blood cell count, 5.54 × 109/L, a case report by Spinello Antinori et al (6).

No study has reported any major bleeding complication or mortality resulting from even severe thrombocytopenia (platelet count under 50,000/μL) (33,34). In our study, we found the majority of mild and moderate thrombocytopenia among P. vivax malaria patients and this observation supports previous reports in isolated literature pertaining to thrombocytopenia in vivax malaria (35–37). Only a few studies have so far reported mortality from P. vivax infection; some have reported multiple complications, but none of these studied the adult population exclusively (38). Reports on the association of platelet count with peripheral parasitemia have been contradictory. Some studies have reported a negative correlation (38), while many studies in Brazil and Ethiopia confirmed a positive correlation (33) The significance of this observation is still unknown.

Conclusion

These findings highlight the importance of monitoring platelet counts and comprehending the clinical significance of thrombocytopenia in vivax malaria management. Further research is needed to gain a comprehensive understanding of the underlying mechanisms and clinical implications of thrombocytopenia in vivax malaria.

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REFRENCES

1. Aijaz A. ORIGINAL ARTICLE SEVERITY OF THROMBOCYTOPENIA IN PATIENTS WITH PLASMODIUM VIVAX MALARIA ; A SINGLE CENTER STUDY Muhammad Hafeez , Faisal Rashid Lodhi *, Zaheer Akhtar **, M Zafar Ali ***, Anjum Aijaz †. 2015;27(1):61–3.
2. Awoke N, Arota A. Profiles of hematological parameters in plasmodium falciparum and plasmodium vivax malaria patients attending tercha general hospital, Dawuro zone, south Ethiopia. Infect Drug Resist. 2019;12:521–7.
3. Cruz-Coke R. Mendel en la historia de la medicina. Vol. 101, Revista medica de Chile. 1973. 252–256 p.
4. Singh B, Daneshvar C. Human infections and detection of plasmodium knowlesi. Clin Microbiol Rev. 2013;26(2):165–84.
5. RESEARCH PAPERS CLASSIFICATION OF Plasmodium SPECIES IN MALARIA INFECTED BLOOD CELL IMAGES AND. 2021;10(1):2021.
6. Khan MI, Qureshi H, Bae SJ, Khattak AA, Anwar MS, Ahmad S, et al. Malaria prevalence in Pakistan: A systematic review and meta-analysis (2006–2021). Heliyon [Internet]. 2023;9(4):e15373. Available from: https://doi.org/10.1016/j.heliyon.2023.e15373
7. World Health Organization. Global technical strategy for malaria 2016–2030. World Heal Organ [Internet]. 2016;1–35. Available from: https://apps.who.int/iris/bitstream/handle/10665/186671/9789243564999_spa.pdf?sequence=1
8. Lacerda MV, Mourão MP, Alexandre MA, Siqueira AM, Magalhães BM, Martinez-Espinosa FE, et al. Understanding the clinical spectrum of complicated Plasmodium vivax malaria: A systematic review on the contributions of the Brazilian literature. Malar J. 2012;11:1–18.
9. Ampadu HH, Asante KP, Bosomprah S, Akakpo S, Hugo P, Gardarsdottir H, et al. Prescribing patterns and compliance with World Health Organization recommendations for the management of severe malaria: A modified cohort event monitoring study in public health facilities in Ghana and Uganda. Malar J [Internet]. 2019;18(1):1–8. Available from: https://doi.org/10.1186/s12936-019-2670-9
10. Antonelli LR, Junqueira C, Vinetz JM, Golenbock DT, Ferreira MU, Gazzinelli RT. The

immunology of Plasmodium vivax malaria. Immunol Rev. 2020;293(1):163–89.
11. Aggarwal S, Peng WK, Srivastava S. Multi-omics advancements towards Plasmodium vivax malaria diagnosis. Diagnostics. 2021;11(12).
12. Beeson JG, Chu CS, Richards JS, Nosten F, Fowkes FJI. Plasmodium vivax malaria: Challenges in diagnosis, treatment and elimination. Pediatr Infect Dis J. 2015;34(5):529–31.
13. Hurt AC, Barr IG. Rapid diagnostic tests for influenza. Revolutionizing Trop Med Point-of-Care Tests, New Imaging Technol Digit Heal. 2019;191–201.
14. Fitri LE, Widaningrum T, Endharti AT, Prabowo MH, Winaris N, Nugraha RYB. Malaria diagnostic update: From conventional to advanced method. J Clin Lab Anal. 2022;36(4):1–14.
15. Ferreira MU, Nobrega de Sousa T, Rangel GW, Johansen IC, Corder RM, Ladeia-Andrade S, et al. Monitoring Plasmodium vivax resistance to antimalarials: Persisting challenges and future directions. Int J Parasitol Drugs Drug Resist. 2021;15(October 2020):9–24.
16. Arif M, Jelia S, Meena S, Meena S, Jain P, Ajmera D, et al. A study of thrombocytopenia in malaria and its prognostic significance. Int J Res Med Sci. 2016;4(6):2373–8.
17. Martínez-Salazar EL, Tobón-Castaño A. Platelet profi le is associated with clinical complications in patients with vivax and falciparum malaria in Colombia. Rev Soc Bras Med Trop. 2014;47(3):341–9.
18. Gopalakrishnan NT, Papaiah S, Soman S, Upadhyaya K. A Clinicopathological Study of Thrombocytopenia in Malaria Cases with Its Evaluation in Different Types of Malaria. 2021;10(33):2–6.
19. Iqbal S, Sardar J, Khan HA, Abbas G, Mehmood B, Khan BS. ANALYSIS OF HAEMATOLOGICAL COMPLICATIONS IN VIVAX AND FALCIPARUM MALARIA IN IN-DOOR PATIENTS IN A TERTIARY CARE HOSPITAL IN PAKISTAN. 2023;31(2):149–52.
20. Article O, Waseem N, Nasir H, Hassan KA. FREQUENCY OF THROMBOCYTOPENIA IN CONFIRMED CASES OF. 2023;34(02):103–6.
21. Hanson J, Phu NH, Hasan MU, Charunwatthana P, Plewes K, Maude RJ, et al. The clinical implications of thrombocytopenia in adults with severe falciparum malaria: A retrospective analysis. BMC Med. 2015;13(1):1–9.
22. Ullah I, Zeb MA, Ullah A, Jamal SF, Khan MA. Original Article Hematological Profile of Plasmodium Vivax and Plasmodium Falciparum Infected Patients Compared With Control Group in Hayatabad Medical Complex , Peshawar. Ann Allied Heal Sci. 2021;Vol. 07, N:21–6.
23. Idrees F, Reporting M, Words K. Pakistan journal of health sciences. 2022;(c):2017–8.
24. Darraj MA. Clinical Profile of Severe Plasmodium falciparum and P . vivax Malaria in Jazan Region , Saudi Arabia. 2020;16(11):73–80.
25. Choudhary PK, Mainali N. Interpretation on coexistence or association of thrombocytopenia with malaria. 2019;9:1453–6.
26. Anvikar AR, Maria A, Eijk V, Shah A, Upadhyay KJ, Sullivan SA. Clinical and epidemiological characterization of severe Plasmodium vivax malaria in Gujarat , India. Virulence [Internet]. 2020;11(1):730–8. Available from: https://doi.org/10.1080/21505594.2020.1773107
27. Kochar DK, Das A, Kochar A, Middha S, Acharya J, Tanwar GS, et al. Thrombocytopenia in Plasmodium falciparum, Plasmodium vivax and mixed infection malaria: A study from Bikaner (Northwestern India). Platelets. 2010;21(8):623–7.
28. Buss I, Genton B, D'Acremont V. Aetiology of fever in returning travellers and migrants: A systematic review and meta-analysis. J Travel Med. 2020;27(8):1–12.
29. Supraja SSTEKK. Comparison of Hematological Parameters in Various Acute Febrile Illnesses. Int J Sci Res [Internet]. 2018;7(7):799–801. Available from: https://www.ijsr.net/archive/v7i7/ART20183954.pdf
30. Kotepui M, Phunphuech B, Phiwklam N, Chupeerach C, Duangmano S. Effect of malarial infection on haematological parameters in population near Thailand-Myanmar border. Malar J. 2014;13(1):1–7.
31. Gebreweld A, Erkihun Y, Feleke DG, Hailu G, Fiseha T. Thrombocytopenia as a Diagnostic

Marker for Malaria in Patients with Acute Febrile Illness. J Trop Med. 2021;2021.
32. Ourives SS, Borges QI, Sampaio D, Cláudia E, Melo M, Souza RM De, et al. Analysis of the lymphocyte cell population during malaria caused by Plasmodium vivax and its correlation with parasitaemia and thrombocytopaenia. Malar J [Internet]. 2018;1–16. Available from: https://doi.org/10.1186/s12936-018-2443-x
33. Aggarwal A, Rath S, Shashiraj. Plasmodium vivax malaria presenting with severe thrombocytopenia. J Trop Pediatr. 2005;51(2):120–1.
34. Muley A, Lakhani J, Bhirud S, Patel A. Thrombocytopenia in plasmodium vivax malaria: How significant? J Trop Med. 2014;2014.
35. Punnath K, Dayanand KK, Chandrashekhar VN, Achur RN, Kakkilaya SB, Ghosh SK, et al. Association between inflammatory cytokine levels and anemia during Plasmodium falciparum and Plasmodium vivax infections in Mangaluru: A Southwestern Coastal Region of India. Trop Parasitol. 2019;9(2):98–107.
36. Gopalakrishnan NT, Papaiah S, Soman S, Upadhyaya K. A Clinicopathological Study of Thrombocytopenia in Malaria Cases with Its Evaluation in Different Types of Malaria. J Evol Med Dent Sci. 2021;10(33):2707–11.
37. Batool Y, Fatima S, Pervaiz G, Akhtar N, Asif M, Bashir F. Frequency of thrombocytopenia and its severity in patients of Malaria. Prof Med J. 2019;26(09):1398–403.
38. Margono S, Lubis B, Pasaribu S, Wijaya H, Pasaribu AP. The correlation between platelet count and parasite density in children with malaria infection. Asian Pacific J Trop Dis [Internet]. 2016;6(3):199–203. Available from: http://dx.doi.org/10.1016/S2222-1808(15)61013-1