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DISTINGUISHING MALARIA AND DENGUE FEVER IN HYDERABAD, SINDH, PAKISTAN: A FREQUENCY- AND HEMATOLOGY-BASED DIAGNOSTIC FRAMEWORK USING RECENT PAKISTANI EVIDENCE

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Abstract

Malaria and dengue fever remain major causes of acute febrile illness in Pakistan, and both diseases frequently coexist in Sindh, creating practical diagnostic difficulty in outpatient and emergency settings. This paper develops a Hyderabad-focused, frequency- and hematology-based differentiation framework using recent evidence from Pakistan and comparable regional studies published in 2024–2025. The study adopts a qualitative secondary-data design and synthesizes surveillance reports, hospital-based studies, and recent international guidance to answer one applied question: how can malaria and dengue patients be distinguished early when molecular confirmation is delayed, unavailable, or selectively used? The review shows that malaria remains a high-burden disease in Pakistan, with over 2 million annual confirmed cases in 2024 and persistent transmission strengthened by climate variability and flood-linked ecological change. Dengue also expanded sharply, with Pakistan reporting about 20,000 cases by the end of 2024 and repeated post-monsoon surges in Sindh. Across the reviewed literature, thrombocytopenia appears in both diseases and is therefore insufficient as a stand-alone discriminator. The more useful distinction is pattern-based: dengue more consistently clusters with leukopenia, lower total white cell counts, relative hemoconcentration, and sometimes elevated transaminases, whereas malaria more often presents with anemia, thrombocytopenia, and a normal or variably altered white cell count, especially in Plasmodium vivax dominant settings. Based on these findings, the paper proposes a Sequential Febrile-Hematological Differentiation Framework for Hyderabad that combines local frequency, seasonality, complete blood count patterns, and confirmatory testing. The paper concludes that a frequency-aware hematological triage model can improve early case separation in Hyderabad, reduce diagnostic delay, and support more rational use of dengue serology, malaria microscopy, and rapid diagnostic testing in resource-constrained care pathways.

INTRODUCTION

Malaria and dengue fever continue to pose a serious public-health challenge in Pakistan, particularly in provinces such as Sindh where climatic variability, post-monsoon water accumulation, population density, and uneven vector-control systems create favorable conditions for the transmission of both diseases. Although malaria is caused by *Plasmodium* parasites and dengue is a viral infection transmitted by *Aedes*

mosquitoes, both frequently present as acute febrile illness with overlapping symptoms, including fever, headache, myalgia, weakness, nausea, and generalized malaise. This overlap creates practical diagnostic difficulty, especially in busy outpatient departments, emergency units, and resource-constrained laboratories where early confirmatory testing may be delayed or selectively used. Recent WHO reporting has emphasized that Pakistan remains heavily affected by malaria, with over 2 million reported cases annually, while dengue has also become a recurrent public-health concern in urban and peri-urban settings across the country (WHO EMRO, 2025; WHO, 2025).

The malaria burden in Pakistan has become more complex in the context of climate change, flooding, and ecological disruption. In April 2025, WHO and Pakistan's Ministry of National Health Services warned that climate change is worsening malaria transmission in the country by expanding breeding conditions, intensifying flood-related outbreaks, and increasing seasonal uncertainty. WHO further noted that Pakistan screened over 11.4 million suspected cases in 2024 and treated around 2 million confirmed malaria cases, underlining that malaria remains a routine and widespread diagnostic reality rather than a rare febrile illness (WHO EMRO, 2025). At the global level, the *World Malaria Report 2024* also described continuing pressure on malaria control due to climate shocks, vector adaptation, and fragile health systems, reinforcing the need for localized diagnostic strategies in endemic countries such as Pakistan (WHO, 2024).

Sindh is especially relevant in this context because it has remained one of Pakistan's most active malaria landscapes over the last decade. A 2025 subnational analysis of malaria burden in Sindh found substantial and geographically uneven transmission across the province and identified persistent wet-season and post-monsoon peaks. The study also observed that the impact of the 2022 floods appears to have extended into later years, including 2024 and beyond, suggesting that environmental disruption continues to shape malaria ecology in Sindh (Baig et al., 2025). Although Hyderabad was not singled out as one of the highest-burden districts in that study, its importance as a major urban center and referral hub in Sindh means that its hospitals and diagnostic facilities are influenced by wider provincial transmission patterns and by patient flows from surrounding districts (Baig et al., 2025).

Dengue fever has followed a different but equally serious trajectory in Pakistan. By the end of 2024, Pakistan had reported approximately 20,000 dengue cases, and recent literature has described the disease as a rising national burden with recurring surges that place pressure on surveillance and clinical services. A 2025 commentary on Pakistan's dengue burden argued that the country has entered a phase in which dengue is no longer only an outbreak-driven problem but a sustained seasonal and urban threat requiring stronger prevention and faster diagnosis (Khan et al., 2025). WHO's 2024 global dengue update also highlighted the rapid international increase in dengue cases and linked this trend to urbanization, weak vector control, changing rainfall patterns, and rising temperatures, all of which are relevant to Pakistan's epidemiological setting (WHO, 2024).

Hyderabad, Sindh, is an especially important setting for studying the distinction between malaria and dengue because it combines urban density with exposure to seasonal vector-borne disease risk. While recent Hyderabad-specific dengue studies are limited, a 2024 study on dengue prevalence, risk factors, and serological diagnosis in Hyderabad, Sindh, confirms that dengue has been a persistent and clinically significant concern in the city over time. This matters because clinicians in Hyderabad must often evaluate febrile patients in a setting where both malaria and dengue remain plausible depending on season, local ecology, and patient origin. In such environments, diagnostic reasoning cannot rely on symptoms alone, because both diseases may initially resemble one another before their full clinical or laboratory profiles become apparent (Arain et al., 2024).

For this reason, hematological manifestations have become increasingly important in routine differentiation between the two diseases. Complete blood count testing is relatively

accessible in many Pakistani hospitals and laboratories, making it a practical tool for early triage. Recent Pakistani studies suggest that dengue is more commonly associated with thrombocytopenia together with leukopenia and, in some cases, hemoconcentration or raised hematocrit. A 2025 study from Taxila found that thrombocytopenia and leucopenia, especially when accompanied by elevated liver transaminases, strongly supported dengue diagnosis (Umar et al., 2025). Another 2025 study reported that dengue patients commonly showed thrombocytopenia, leukopenia, and raised hematocrit, supporting the idea that CBC findings can assist early suspicion before confirmatory serology is finalized (Patel et al., 2025).

Malaria, however, tends to show a different hematological direction. Recent Pakistani evidence indicates that anemia and thrombocytopenia are among the most common manifestations of malaria, while white blood cell counts often remain normal or fluctuate less consistently than in dengue. A 2025 cross-sectional study on malaria reported anemia in more than three-quarters of patients and found thrombocytopenia to be highly prevalent, whereas total leukocyte counts were normal in the majority of cases (Qaiser et al., 2025). A 2025 study from the Liaquat University of Medical and Health Sciences context similarly found that severe malaria was strongly associated with severe anemia and thrombocytopenia, especially in more serious infections (Kanwal et al., 2025). These findings suggest that although both diseases may show reduced platelet counts, malaria is more strongly linked with red-cell destruction and anemia, while dengue more often presents with platelet decline plus leukopenia and hemoconcentration (Qaiser et al., 2025; Kanwal et al., 2025).

The clinical implication of this overlap is important. Thrombocytopenia alone cannot safely distinguish dengue from malaria, because it is common in both. What appears more useful is a pattern-based interpretation that combines disease frequency, seasonality, and hematological clustering. In other words, the diagnostic question should not simply be whether the platelet count is low, but whether low platelets appear alongside anemia, leukopenia, normal white counts, rising hematocrit, or other supporting findings. This pattern-based approach is particularly relevant for Hyderabad because laboratory and clinical decisions are often made under time pressure and with varying access to microscopy, malaria rapid diagnostic tests, NS1 antigen testing, and dengue serology (Umar et al., 2025; Qaiser et al., 2025).

This study therefore investigates how malaria and dengue fever can be distinguished in Hyderabad, Sindh, by using recent evidence on disease frequency and hematological manifestations. Rather than treating the two diseases as separate clinical pathways from the start, the paper argues that a more effective strategy is to integrate epidemiological likelihood with hematological interpretation. The central assumption is that a frequency-aware hematological model can improve early suspicion, guide the order of confirmatory testing, and support faster triage in Hyderabad's healthcare settings. The study is especially timely because both diseases remain active in Pakistan, and recent environmental and climatic pressures continue to reshape vector-borne disease patterns across Sindh and beyond (WHO EMRO, 2025; Baig et al., 2025; Khan et al., 2025).

In this paper, the problem is approached through a new applied idea: a frequency- and hematology-based differentiation model for Hyderabad. The paper proposes that early distinction is improved when clinicians use three linked questions in sequence: which disease is more epidemiologically likely at that time, which hematological pattern is present, and which confirmatory test should therefore be prioritized first? This approach aims to move beyond symptom overlap and toward a structured triage logic suited to endemic, resource-variable settings. By focusing on Hyderabad, the study also contributes a city-specific applied perspective to the broader Pakistani literature on malaria, dengue, and laboratory-based differentiation.

REVIEW OF LITERATURE

The recent literature on malaria and dengue in Pakistan increasingly treats both diseases as part of a broader acute febrile illness problem rather than as fully separate epidemiological categories. This shift is important because in endemic settings, especially in South Asia, clinicians often encounter fever before they encounter a confirmed diagnosis. WHO's 2024 dengue update and WHO's 2024 malaria reporting both emphasize that changing climate conditions, urbanization, weak vector control, and health-system strain are making vector-borne febrile diseases more difficult to predict and manage, especially in lower- and middle-income countries. In such contexts, the challenge is not only treatment after confirmation, but early differentiation while laboratory certainty is still developing (WHO, 2024; WHO, 2025). (who.int) (who.int)

A major strand in the recent malaria literature concerns scale and persistence. WHO and Pakistan jointly reported in 2025 that malaria remains one of the country's most urgent infectious-disease burdens, with around 2 million confirmed cases annually. Their statement also links the rise in malaria transmission to climate change, especially warming temperatures, prolonged mosquito breeding seasons, and flood-related ecological disruption. This is important for the present study because it confirms that malaria in Pakistan is not declining into epidemiological irrelevance. Instead, it remains highly plausible as a frontline diagnosis in Sindh and continues to exert pressure on routine febrile care pathways (WHO EMRO, 2025). (emro.who.int)

The Sindh-specific literature reinforces this view. A 2025 subnational malaria-burden analysis based on over a decade of evidence and data from 1,088 primary healthcare facilities found that malaria transmission in Sindh is spatially uneven but persistently active. The authors identified six districts carrying more than half of the total burden and showed that monsoon seasonality, service variation, and ecological conditions strongly shape district-level patterns. Although Hyderabad was not listed among the six highest-burden districts, the study is still critical for this paper because it situates Hyderabad inside a province with active malaria transmission and major patient mobility between districts and urban service centers. This means that Hyderabad's febrile illness burden cannot be understood in isolation from wider Sindh epidemiology (Baig et al., 2025). (link.springer.com)

The dengue literature from Pakistan has developed in a somewhat different direction, focusing more strongly on urban outbreaks, seasonality, and rapidly rising incidence. A 2025 Pakistan-focused article on the rising dengue burden argues that dengue has become a serious and sustained public-health concern in the country, with around 20,000 cases reported by the end of 2024. The authors describe dengue in Pakistan as a disease no longer limited to isolated epidemic waves, but one increasingly shaped by weak urban environmental management, post-monsoon mosquito proliferation, and recurrent health-system stress. This is directly relevant to Hyderabad, where urban conditions and seasonal rainfall can create ideal environments for *Aedes* breeding and recurrent dengue risk (Khan et al., 2025). (pmc.ncbi.nlm.nih.gov)

WHO's 2024 global dengue situation update also supports this argument. It recorded an unprecedented global increase in dengue and linked this rise to urbanization, irregular rainfall, temperature change, and the widening distribution of *Aedes* mosquitoes. The relevance of that literature to Pakistan is straightforward: dengue transmission is becoming harder to contain because its ecological basis is expanding. In practical diagnostic terms, that means more febrile patients in urban Pakistan are likely to enter health facilities during dengue season with symptoms that overlap strongly with malaria and other febrile diseases (WHO, 2024). (who.int)

A second major strand in the literature concerns hematological manifestations. Here the evidence becomes clinically more useful. Several recent Pakistani studies suggest that dengue tends to present a more recognizable pattern of thrombocytopenia accompanied by leukopenia, and in some cases by raised hematocrit or

biochemical changes. In a 2025 retrospective study from HIT Hospital, Taxila, thrombocytopenia and leucopenia were identified as strong indicators of dengue fever, especially when accompanied by elevated SGPT. The study's conclusion was important because it suggested that low platelet count alone was insufficient, but low platelet count together with low white blood cell count considerably strengthened dengue suspicion (Umar et al., 2025). (thejas.com.pk)

This pattern is echoed in another 2025 study published in the *International Journal of Clinical and Diagnostic Pathology*. That study analyzed 100 dengue cases and reported thrombocytopenia in 88% of patients, leucopenia in 39%, increased hematocrit in 15%, and abnormal lymphocyte patterns in a substantial minority. The authors concluded that CBC changes—especially thrombocytopenia, leucopenia, and raised hematocrit—can support early recognition of dengue and help clinicians identify potentially severe cases before full clinical deterioration occurs. This is particularly valuable for the current research because it demonstrates that routine hematology can provide meaningful guidance in low-cost diagnostic environments (Patel et al., 2025). (patholjournal.com)

A 2025 dengue study from Peshawar adds further support, although with somewhat lower frequencies. It found leukopenia in 22.4% of cases, thrombocytopenia in 12.5%, raised hematocrit in 17.4%, and reduced hemoglobin in 19.4%. While the absolute values differ from the Taxila and pathology-based studies, the broader pattern still points in the same direction: dengue tends to lower platelet counts and often depresses total white cell count, whereas strong anemia is not usually its leading hematological hallmark. This variation across studies also suggests that hematological manifestations depend partly on disease stage, population, and case severity, which is why a pattern-based approach is preferable to a single-value rule (Gul et al., 2025). (jsmc.pk)

The malaria hematology literature from Pakistan points in a different but equally strong direction. A 2025 cross-sectional analytical study examining hematological changes in malaria reported anemia in 76.4% of patients, with thrombocytopenia also highly prevalent. Crucially, the study found that total leukocyte count remained normal in the majority of cases and that leukopenia was present in a smaller proportion. The dominant species in that cohort was *Plasmodium vivax* (81%), followed by *P. falciparum* (19%). This matters because it shows that even in vivax-dominant Pakistani settings, malaria commonly produces anemia and platelet decline, while the white cell pattern is less characteristically depressed than in dengue (Qaiser et al., 2025). (jptcp.com)

Additional support comes from a 2025 severe-malaria study linked to the Liaquat University of Medical and Health Sciences context. That study focused on children with severe malaria and found severe anemia in 74.5% of patients and thrombocytopenia in 67.4%, particularly among *P. falciparum* infections. Although the patient group was pediatric and involved severe disease, the study reinforces the same broader conclusion: malaria's hematological burden is closely tied to red-cell destruction, hemolysis, and platelet loss, and far less consistently to the leukopenic picture that is often associated with dengue (Kanwal et al., 2025). (lumhs.edu.pk)

Taken together, these findings suggest a central point that is often obscured in routine practice: thrombocytopenia overlaps too much to serve as a decisive separator. Both dengue and malaria can produce low platelet counts, sometimes significantly so. What distinguishes them more effectively is the pattern around the platelet count. In dengue, thrombocytopenia tends to cluster with leukopenia, relative hemoconcentration, and occasionally elevated liver enzymes. In malaria, thrombocytopenia tends to cluster with anemia and a white cell profile that is normal or only variably altered. This comparative insight is one of the strongest findings in the recent literature and forms the clinical basis for this paper's framework (Umar et al., 2025; Qaiser et al., 2025). (thejas.com.pk)

A third strand in the literature concerns seasonality and diagnostic timing**.** Both malaria and dengue are environmentally sensitive, but their temporal expression differs. Malaria in

Pakistan remains tied to broader ecological conditions and can persist across longer periods, especially in flood-affected and peri-urban areas. Dengue, by contrast, tends to surge more sharply in relation to monsoon and post-monsoon urban mosquito breeding. This distinction is not merely epidemiological; it is also diagnostic. A fever case in Hyderabad during post-monsoon months with thrombocytopenia and leukopenia may carry a different pre-test probability than a similar case during months when malaria transmission dominates in surrounding districts. The literature therefore supports a model in which disease frequency and local seasonality are treated as integral parts of diagnosis rather than as background information (WHO EMRO, 2025; Baig et al., 2025; Khan et al., 2025). (emro.who.int)

Theoretical Framework: Sequential Febrile-Hematological Differentiation Framework (SFHDF)

This paper adopts a new applied framework called the Sequential Febrile-Hematological Differentiation Framework (SFHDF). The framework is designed for cities like Hyderabad, where patients often present first with undifferentiated fever, and where CBC testing is commonly available before more disease-specific confirmatory testing is completed. The framework is grounded in the recent literature reviewed above and is built on the assumption that early differentiation improves when epidemiological likelihood and hematological pattern are read together.

The first stage of the framework is frequency and seasonality assessment**.** At this stage, the clinician asks which disease is more epidemiologically likely in Hyderabad at that moment. The literature supports the idea that malaria remains continuously relevant in Sindh, while dengue risk increases especially in urban and post-monsoon conditions. This stage is important because the same CBC pattern may have different interpretive value depending on the surrounding epidemiological context (Baig et al., 2025; Khan et al., 2025). (link.springer.com)

The second stage is hematological clustering**.** Here the framework does not look for one abnormality in isolation. Instead, it asks which abnormalities appear together. If thrombocytopenia appears with leukopenia, rising hematocrit, or liver-enzyme disturbance, dengue becomes more likely. If thrombocytopenia appears with anemia and a relatively normal or less suppressed white blood cell count, malaria becomes more likely. This stage comes directly from the pattern-recognition logic emerging across the 2025 Pakistani studies on dengue and malaria hematology (Umar et al., 2025; Qaiser et al., 2025; Patel et al., 2025). (patholjournal.com)

The third stage is confirmatory sequencing. Once the frequency and hematological profile have been interpreted, the clinician prioritizes the most appropriate confirmatory test. In a Hyderabad setting, this means that a febrile patient with anemia plus thrombocytopenia should move quickly toward malaria microscopy or RDT, while a febrile patient with thrombocytopenia plus leukopenia should prompt early dengue NS1 or serology. The framework does not replace confirmatory diagnosis, but it aims to make confirmatory testing more rational, timely, and context-sensitive. This is especially relevant in settings where laboratory resources are uneven and not every patient can immediately receive the full panel of tests (WHO, 2025; WHO EMRO, 2025). (who.int)

The fourth stage is severity signaling**.** The literature reviewed above suggests that some hematological combinations do more than assist diagnosis; they also warn of deterioration. In dengue, falling platelets with leukopenia and rising hematocrit may indicate progression toward plasma leakage or more severe disease. In malaria, profound anemia and thrombocytopenia may signal severe infection, especially in *P. falciparum*. This stage transforms the framework from a diagnostic model into a triage tool that can support earlier referral and closer monitoring when needed (Patel et al., 2025; Kanwal et al., 2025). (lumhs.edu.pk)

Gap in the Literature

The recent literature is strong in describing malaria burden, dengue burden, and hematological changes in each disease separately. However, there remains a clear gap in **integrated, city-applicable differentiation models** for places like Hyderabad. Most studies either focus on malaria or dengue in isolation, or they report laboratory findings without translating them into a structured diagnostic sequence for real-world febrile practice. There is also limited recent work that combines Sindh-specific disease frequency with CBC interpretation in a practical framework aimed at improving early distinction. This paper addresses that gap by integrating recent 2024–2025 evidence into one applied model for Hyderabad, Sindh (Baig et al., 2025; Khan et al., 2025). (pmc.ncbi.nlm.nih.gov)

Relevance to the Present Study

The literature reviewed here directly supports the central premise of the present study: malaria and dengue in Hyderabad should be distinguished not by one laboratory marker alone, but by combining local frequency, seasonality, and hematological clustering. This approach is consistent with the realities of Pakistani healthcare settings, where symptoms overlap, CBC is often available earlier than full confirmation, and both diseases remain epidemiologically important. By applying the SFHDF framework, the present study seeks to move beyond descriptive comparison and toward a more operational model for diagnosis and triage in Hyderabad, Sindh (WHO EMRO, 2025; Umar et al., 2025; Qaiser et al., 2025). (jptcp.com)

RESEARCH METHODOLOGY

This study uses a qualitative secondary-data analytical design with an applied diagnostic orientation. The purpose is not to estimate incidence from a primary Hyderabad cohort, because such patient-level data were not publicly available for this paper. Instead, the study synthesizes recent 2024–2025 surveillance data, Pakistan-based clinical studies, and international guidance to construct an evidence-based differentiation model suitable for Hyderabad, Sindh. This design is appropriate when the research goal is to develop a context-sensitive diagnostic interpretation from multiple recent datasets rather than to test a single primary hypothesis in one hospital sample.

The study is anchored in document analysis and comparative clinical synthesis. Document analysis was used to collect evidence on disease frequency, seasonality, surveillance burden, and public-health context. Comparative clinical synthesis was used to identify recurrent hematological patterns in malaria and dengue from recent Pakistani studies. These two strands were then combined within the Sequential Febrile-Hematological Differentiation Framework.

Study setting

The intended application setting is Hyderabad, Sindh, Pakistan. Hyderabad is epidemiologically relevant because it lies in a province with persistent malaria transmission and repeated dengue activity, while also serving as a referral and urban clinical node for nearby populations. Because district-specific recent hematological cohort data for Hyderabad were not publicly accessible, the study uses Sindh-wide malaria evidence and Pakistan-based dengue and malaria hematology studies as the best available evidence base for Hyderabad-oriented inference.

Data sources

The data sources were selected from five categories.

The first category comprised international epidemiological sources, especially WHO malaria and dengue updates from 2024–2025, to establish current disease burden and transmission context.

The second category included Pakistan or Sindh burden sources, especially the 2025 Sindh subnational malaria burden study and Pakistan dengue-burden commentary. These sources were used to anchor the paper in local public-health reality.

The third category consisted of recent Pakistani clinical studies on dengue hematology, including studies from Taxila and Peshawar. These were

used to identify the most consistent CBC and related laboratory manifestations associated with dengue in Pakistani settings.

The fourth category consisted of recent Pakistani clinical studies on malaria hematology, including adult and pediatric malaria studies from 2025. These were used to define the more characteristic malaria-associated patterns in hemoglobin, platelet count, and leukocyte profile.

The fifth category included recent WHO guidance and Pakistan-facing disease-risk commentary, which helped contextualize how climate, floods, and surveillance limitations complicate diagnosis in endemic settings.

DATA COLLECTION AND ANALYSIS

Frequency profile: why malaria and dengue both matter in Sindh

The first analytical finding is that both diseases are frequent enough in Pakistan to create real diagnostic competition. WHO and Pakistan stated in April 2025 that more than 2 million confirmed malaria cases were reported in Pakistan in 2024 and that climate-linked ecological change continues to sustain transmission. This means malaria remains a routine diagnostic concern rather than an occasional rural exception.

For dengue, the pattern is different but equally relevant. The 2025 Pakistan dengue-burden commentary reported around 20,000 cases by the end of 2024 and described repeated surges that strain surveillance and response systems. In practical terms, this means that a febrile patient in urban Sindh can plausibly have either disease depending on season, neighborhood ecology, and referral pattern.

Sindh-specific malaria evidence confirms that the province remains one of Pakistan's key malaria landscapes. The 2025 Sindh burden study showed a strong malaria burden across multiple districts and documented long-term continuity rather than sporadic transmission. Although Hyderabad is not among the six highest-burden districts identified, its position within Sindh and its referral role make the provincial pattern directly relevant to Hyderabad-based clinicians.

Hematological profile of dengue

The second analytical finding is that dengue has a more recognizably leukopenic-thrombocytopenic profile. In the 2025 Taxila dengue study, leucopenia and thrombocytopenia were identified as high-likelihood markers of dengue, particularly when combined with elevated liver transaminases.

A separate 2025 study of 100 dengue cases found thrombocytopenia in 88% of patients, leucopenia in 39%, raised hematocrit in 15%, and relative lymphocytosis or reactive lymphocytes in a meaningful minority. The study concluded that thrombocytopenia plus leukopenia, especially with rising hematocrit, supports early recognition of dengue and more severe forms of the disease.

The 2025 Peshawar series also supports this direction, though with lower absolute percentages. It reported leukopenia in 22.4%, thrombocytopenia in 12.5%, low hemoglobin in 19.4%, and raised hematocrit in 17.4%. The lower rates likely reflect case-mix differences, but the pattern remains clinically important: dengue is more often associated with falling platelets and suppressed white counts than with dominant anemia.

Table: Disease Frequency Profile in Pakistan and Sindh

Indicator	Malaria	Dengue	Analytical Implication for Hyderabad
National burden in recent reporting	Around 2 million confirmed cases annually in Pakistan in 2024 (WHO EMRO, 2025)	Around 20,000 reported cases in Pakistan by the end of 2024 (Khan et al., 2025)	Both diseases remain clinically relevant; malaria shows heavier structural burden, while dengue shows strong outbreak potential
Ecological driver	Climate change, floods, standing water, prolonged vector season (WHO EMRO, 2025)	Urbanization, post-monsoon breeding, rainfall, temperature rise (WHO, 2024; Khan et al., 2025)	Hyderabad is exposed to both rural-peri-urban and urban vector ecologies
Sindh-specific relevance	Persistent malaria burden across Sindh with district variation (Baig et al., 2025)	Recurrent dengue risk in urban settings and seasonal surges (Khan et al., 2025)	Hyderabad should be treated as a mixed-risk diagnostic zone
Frequency interpretation	Endemic and continuously important	Seasonal and surge-prone	Frequency and seasonality must guide pre-test suspicion

Note: This table is prepared for inclusion in the Data Collection and Analysis section of the research paper and can be renumbered to match the final thesis or journal formatting.

Hematological profile of malaria

The third analytical finding is that malaria has a more recognizably anemia-thrombocytopenia profile. In the 2025 adult malaria study, anemia was present in 76.4% of patients, while thrombocytopenia of varying severity was common and white blood cell counts remained normal in 71.5% of patients. Leukopenia occurred, but far less consistently than in dengue-focused literature.

The LUMHS-linked 2025 severe malaria study strengthens this pattern from a Sindh-relevant perspective. It reported severe anemia in 74.5% and thrombocytopenia in 67.4%, especially among *P. falciparum* cases. These findings underline that malaria's hematological signature is driven more by red-cell loss and platelet reduction than by a stable leukopenic picture.

The species mix also matters. The 2025 adult malaria study found *Plasmodium vivax* in 81% of cases and *P. falciparum* in 19%. That matters for Hyderabad and Sindh because *P. vivax* remains dominant across much of Pakistan, meaning clinicians should expect anemia and thrombocytopenia even when falciparum-specific severe syndromes are absent.

Table: Hematological Pattern of Dengue Fever

Hematological / Laboratory Feature	Recent Evidence	Diagnostic Value
Thrombocytopenia	Common and prominent in dengue cases; reported in 88% in one 2025 study (Patel et al., 2025)	Important warning sign, but not disease-specific
Leukopenia	Frequently reported; found as a strong indicator in Pakistani studies (Umar et al., 2025)	More supportive of dengue when present with thrombocytopenia
Raised hematocrit / hemoconcentration	Reported in dengue and linked with more serious illness (Patel et al., 2025)	Helps differentiate dengue from malaria when combined with low platelets
Elevated liver enzymes	Reported in dengue patients in recent Pakistani evidence (Umar et al., 2025)	Supports dengue suspicion in compatible cases
Hemoglobin pattern	Usually not dominated by marked anemia early in illness	Makes dengue less likely when strong anemia is present

Comparative interpretation

When the data are compared across diseases, one point becomes immediately clear: thrombocytopenia is shared, so it cannot by itself distinguish malaria from dengue. Dengue studies repeatedly describe low platelets, and malaria studies also show frequent thrombocytopenia. Therefore, platelet decline is a warning sign, not a stand-alone discriminator.

The more useful separator is the association pattern around platelets. In dengue, thrombocytopenia tends to cluster with leukopenia, relative lymphocytic change, or rising hematocrit. In malaria, thrombocytopenia tends to cluster with anemia and often with a comparatively normal total white blood cell count. This distinction is the core analytical contribution of the paper.

A second useful separator is hemoglobin behavior. While some dengue patients do show low hemoglobin, anemia is not usually the dominant early hallmark in the way it is in malaria. By contrast, recent malaria studies consistently report anemia as one of the most frequent abnormalities. In a Hyderabad triage setting, thrombocytopenia plus meaningful anemia should raise early malaria suspicion unless dengue is otherwise strongly supported clinically or by serology.

A third separator is hematocrit direction. Dengue is more likely to show hemoconcentration or a rising hematocrit pattern when plasma leakage is developing, while malaria more often lowers the red-cell mass through hemolysis and anemia. This does not eliminate overlap, but it improves the direction of early clinical reasoning.

Table: Hematological Pattern of Malaria

Hematological / Laboratory Feature	Recent Evidence	Diagnostic Value
Anemia	Reported in 76.4% of malaria cases in a 2025 study (Qaiser et al., 2025)	Strongly supports malaria, especially with fever and thrombocytopenia
Thrombocytopenia	Common in malaria across recent studies (Qaiser et al., 2025; Kanwal et al., 2025)	Important but not sufficient alone for differentiation
White blood cell count	Often normal in malaria; normal TLC reported in the majority of cases (Qaiser et al., 2025)	Helps distinguish malaria from dengue when leukopenia is absent
Severe anemia in complicated malaria	Strongly present in severe malaria, especially in P. falciparum (Kanwal et al., 2025)	Useful severity marker and malaria indicator
Species pattern	Plasmodium vivax dominant in one recent Pakistani series (Qaiser et al., 2025)	Suggests malaria remains likely even outside classic falciparum-dominant severe presentations

Hyderabad-applicable differentiation model

From the above evidence, the Hyderabad-applicable diagnostic sequence can be stated as follows. If a febrile patient presents during a high dengue period with thrombocytopenia plus leukopenia, especially if hematocrit is rising or transaminases are abnormal, dengue should be prioritized and NS1 or dengue serology ordered promptly.

If a febrile patient presents with thrombocytopenia plus anemia, especially with pallor, chills, or a white blood cell count that is normal or only mildly altered, malaria should move higher in the differential and microscopy or malaria RDT should be prioritized.

If both diseases remain plausible because the CBC shows thrombocytopenia without a clear accompanying pattern, then local frequency and seasonality should decide the first test, but both malaria and dengue confirmation should remain under consideration. This is the operational value of integrating frequency with hematology rather than relying on laboratory values in isolation.

Table: Comparative Hematological Distinction Between Malaria and Dengue

Parameter	Dengue Fever	Malaria	More Suggestive of
Platelet count	Low	Low	Shared by both; not sufficient alone
White blood cell count	Often low (leukopenia)	Often normal or variably altered	Dengue when low
Hemoglobin	Usually relatively preserved early; severe anemia less dominant	Frequently reduced	Malaria when low
Hematocrit	May rise due to hemoconcentration	Usually not characteristically raised; anemia more common	Dengue when raised
Liver enzyme elevation	Often present in dengue studies	May occur, but less central in reviewed distinction	Dengue
Key pattern	Thrombocytopenia + leukopenia ± raised hematocrit	Thrombocytopenia + anemia ± normal WBC	Pattern-based distinction

DISCUSSION

The main contribution of this paper is conceptual and applied. It shows that the problem of distinguishing malaria from dengue in Hyderabad is not best solved by searching for one perfect hematological marker. Instead, it is better solved by combining epidemiological plausibility with pattern recognition in routine CBC findings.

This matters because both diseases remain active in Pakistan, but their frequency behaves differently. Malaria remains structurally persistent and climate-sensitive, while dengue behaves more explosively in seasonal and urbanized patterns. A Hyderabad clinician therefore benefits from asking not only "what does the CBC show?" but also "what is more probable right now in this setting?"

The literature reviewed in this paper consistently shows that thrombocytopenia is common in both conditions. This explains why clinicians who rely only on platelet count can misclassify cases. In resource-constrained settings, platelet count often becomes the most visible abnormality, but the reviewed evidence shows that it should be interpreted together with leukocyte count, hemoglobin, and hematocrit.

A second important insight is that dengue and malaria produce different hematological narratives. Dengue's narrative is more leukopenic and plasma-leak oriented. Malaria's narrative is more hemolytic and anemia-oriented. This does not mean every patient fits the same pattern, but it provides a clinically useful tendency that can structure early decision-making before confirmatory results return.

For Hyderabad, the public-health relevance is substantial. Because the city sits within a province where malaria remains established and dengue risk can rise sharply, clinicians need a low-cost early distinction strategy. CBC is widely available compared with more advanced virology or repeated confirmatory testing. That makes a frequency-aware hematology framework practical, scalable, and relevant to both hospital and high-volume outpatient care.

The paper also suggests a systems implication: diagnostic protocols in Sindh should not present malaria and dengue as separate fever pathways from the start. They should first move through a shared acute febrile assessment pathway, where seasonality, district burden, platelet count, hemoglobin, leukocyte count, and hematocrit are read together before confirmatory branching begins. Such a redesign would be more aligned

with how these cases actually present in real practice.

There are, however, important cautions. First, hematological overlap remains real, especially in early disease and in milder cases. Second, co-infection, though not the focus of this paper, can further blur the picture. Third, laboratory values vary by patient age, hydration status, disease stage, and severity. Therefore, the proposed framework should improve triage and suspicion, not substitute for confirmatory testing.

Even with those cautions, the paper's new idea remains useful: in Hyderabad, a Sequential Febrile-Hematological Differentiation Framework can make diagnosis faster and more rational by pairing what is common locally with what is common biologically. That pairing is the strongest practical lesson of the review.

CONCLUSION

This paper examined how malaria and dengue fever can be distinguished in Hyderabad, Sindh, by using recent evidence on disease frequency and hematological manifestations. It argued that a city like Hyderabad requires a practical differentiation model because it lies within a province where malaria remains persistently important, while dengue continues to rise as a seasonal urban public-health threat.

The evidence reviewed shows that malaria and dengue overlap clinically but diverge meaningfully when frequency and hematology are interpreted together. Thrombocytopenia is common in both diseases and should not be treated as a decisive marker alone. Dengue is more strongly associated with thrombocytopenia plus leukopenia, sometimes with raised hematocrit and biochemical disturbance. Malaria is more strongly associated with thrombocytopenia plus anemia, often with normal or less dramatically suppressed white blood cell counts.

Based on these findings, the paper proposed the Sequential Febrile-Hematological Differentiation Framework for Hyderabad. The framework begins with local epidemiological frequency and seasonality, then interprets CBC patterns, and finally prioritizes confirmatory testing accordingly. This model offers a new, context-sensitive way to separate malaria and dengue earlier in care pathways where diagnostic delay can affect treatment decisions and outcomes.

The study also concludes that future hospital-based work from Hyderabad should validate the framework prospectively using patient-level CBC, malaria microscopy or RDT, dengue NS1 or IgM, and outcome data. Until such local validation is available, the present paper provides an evidence-based diagnostic model that is both practical and adaptable for clinicians and health planners in Sindh.

REFERENCES

Arain, S. Q., Channa, N. A., Talpur, F. N., Memon, N. H., Sheikh, M., & Phull, A. R. (2024). Dengue fever: Prevalence, risk factors and serological diagnosis in Hyderabad, Sindh, Pakistan. *Journal of Fatima Jinnah Medical University, 18*(4), 185–190. https://doi.org/10.37018/AXDS9956

Baig, N., Ali, Z., Fatmi, Z., et al. (2025). Subnational malaria burden in Sindh, Pakistan: Over a decade of evidence for tailored strategies. *Malaria Journal, 24*, Article 265. https://doi.org/10.1186/s12936-025-05505-4

Gul, M., Latifullah, Irshadullah, Asghar, M., Rehman, N., Mahnoor, Azam, S., Hakeem, D., & Khattak, A. A. (2025). Clinico-pathological spectrum of dengue fever among children in District Peshawar. *Journal of Saidu Medical College, 15*(2), 255–260. https://www.jsmc.pk/index.php/jsmc/article/view/1015

Kanwal, N., Qureshi, R., Chander, R., Mumtaz, N., Memon, H., & Kumari, J. (2025). Hematological changes in children with severe malaria. *Journal of Liaquat University of Medical and Health Sciences*. Advance online publication. https://doi.org/10.22442/jlumhs.2025.01352

Khan, M. M., Shakir, M., Bansari, S., Hashmi, B. A., Siddiqui, F. F., Idrees, M., Hussain, S., & Pandeya, A. (2025). Addressing rising dengue burden in Pakistan: Is it time to consider dengue vaccination? *Annals of Medicine and Surgery, 88*(1), 1171–1174. https://doi.org/10.1097/MS9.0000000000004072

Patel, S. S. K., Desai, H., Jayeshbhai, K. V., Pankajbhai, P. U., Bhatia, R. R., & Goswami, H. (2025). Study of hematological parameters in dengue cases. *International Journal of Clinical and Diagnostic Pathology, 8*(1), 122–126. https://doi.org/10.33545/pathol.2025.v8.i1b.2063

Qaiser, A., Ayub, N., Ishtiaq, Q., Tariq, H., Amanyar, H., Gulzar, R., & Gulzar, S. (2025). Evaluation of hematological changes and types of anaemias in malaria. *Journal of Population Therapeutics and Clinical Pharmacology, 32*(4), 466–471. https://jptcp.com/index.php/jptcp/article/view/10154

Umar, S., Javed, A., Aslam, U., Abbas, S. H. B., Yasmin, R., Rauf, M., Javed, A., Sadiq, S., & Rauf, S. (2025). The pattern of hematological and biochemical parameters in dengue fever among patients presenting to HIT Hospital, Taxila Cantt. *Pakistan Journal of Health Sciences, 6*(1), 308–313. https://doi.org/10.54393/pjhs.v6i1.2542

World Health Organization. (2024). *Dengue – Global situation* (Disease Outbreak News, DON518, 30 May 2024). https://www.who.int/emergencies/disease-outbreak-news/item/2024-DON518

World Health Organization. (2024). *World malaria report 2024: Addressing inequity in the global malaria response*. World Health Organization. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2024

World Health Organization. (2025). *Dengue and severe dengue*. https://www.who.int/health-topics/dengue-and-severe-dengue

World Health Organization Eastern Mediterranean Region. (2025, April 25). *WHO and Pakistan warn climate change is worsening malaria amid 2 million annual cases*. https://www.emro.who.int/pak/pakistan-news/who-and-pakistan-warn-climate-change-is-worsening-malaria-amid-2-million-annual-cases.html