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# Clinical Presentation, Molecular Profile, Demographics, and Risk Stratification of Myeloproliferative Neoplasms Presenting in Pakistan

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## Abstract

Objective: To determine the epidemiology and clinical characteristics of Myeloproliferative disorders presenting in Pakistan and to draw comparisons with western population.

Methodology: This cross-sectional observational study was conducted at the Hemato-oncology Department, INMOL Cancer Hospital, Lahore from 15 November 2025 till 15 May 2026.

A total of 163 patients were included in the study by non-probability consecutive sampling. The patients were diagnosed using WHO criteria as Philadelphia chromosome negative MPNs and CML cases. Clinical, laboratory, and molecular data were noted. Data was analyzed using SPSS version 26. Quantitative variables were expressed as mean ± standard deviation, while qualitative variables were presented as frequencies and percentages.

Results: A total of 163 patients were included in the study. Of these, 93 patients were diagnosed with Ph Chromosome negative myeloproliferative neoplasms (MPNs) and 70 patients were diagnosed with CML. Among the 93 MPNs cases, 58 (62.4%) were males and 35 (37.6%) were females. The age of the patients ranged from 19 to 72 years, with a mean age of 46.7 ± 15.2 years. The most frequently diagnosed subtype was essential thrombocythemia (ET) in 41 (44.1%) patients, followed by myelofibrosis (MF) in 29 (31.2%) and polycythemia Vera (PV) in 23 (24.7%) cases. 7 (7.5%) patients experienced AKI as complication in the Ph chromosome negative MPNs. In the 70 CML cases, 43 (61.4%) patients were male while 27 (38.5%) were female. The age of patients ranged from 10 to 70 years with a mean age of 40.2 ± 2.8 years.

Conclusion: The majority of MPNs have demonstrated a distinct pattern with a younger age of presentation and significant molecular associations. The variations with Western data emphasize regional variability and need for improved diagnostics.

Keywords: CML, Myeloproliferative neoplasms, JAK2, CALR, MPL, Splenomegaly, Risk stratification.

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## Introduction

Myeloproliferative disorders also called Myeloproliferative Neoplasms (MPNs) are a group of heterogenous hematopoietic stem cell disorders which are characterized by disordered proliferation of one or more of myeloid cells in the bone marrow.[1] The World health Organization (WHO) has classified these diseases into Philadelphia (Ph) chromosome positive and Ph chromosome negative ones. Chronic Myeloid Leukaemia or CML is a Ph chromosome positive MPN while Polycythaemia Vera (PV), Essential Thrombocythemia (ET), and Primary Myelofibrosis (MF) are part of Ph chromosome negative MPNs.[2] All of these disorders overlap in terms of their clinical as well as haematological features, however, molecular pathogenesis, disease progression and complication and their response to treatment varies.[3] Diagnostic accuracy and risk stratification of all these neoplasms have improved after molecular detection of mutations such as BCR-ABL1 fusion gene in CML or JAK2, CALR and MPL in Ph chromosome negative MPNs.

Amongst adult leukaemia categories, CML accounts for almost 15% of the cases and is characterized by a signature presence of Ph chromosome. The Ph chromosome results from a reciprocal translocation between chromosome numbers 9 and 22 which results in formation of the well-known BCR-ABL1 gene.[3] Patients having presence of this chromosome can present with anemia, fever and splenomegaly. Their peripheral blood shows leucocytosis with left shift (presence of immature granulocytes) and thrombocytosis with progression to blast phase in almost 80% of cases within a few years, if

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not treated timely.[4] The Ph chromosome negative MPNs show a variety of clinical and molecular features which may sometimes overlap. PV is characterized with an increase in erythrocyte proliferation and usually seen associated with JAK2 positivity in majority of cases.[5] ET is usually featured by an increase in platelet count and mutations such as JAK2, MPL and CLAR are seen.[7] It is also often accompanied with thrombotic or haemorrhagic complications.[8] MF, which includes stages such as pre-fibrotic and overt fibrotic stages, presents with increasing bone marrow fibrosis. As a result, constitutional symptoms, hepatosplenomegaly and transformation to leukemia can occur.[9]

Most of the studies conducted worldwide on this topic have demonstrated a relatively older age at the time of diagnosis.[10] In Pakistan, however, the studies remain limited with even fewer centres conducting molecular testing. We conducted this study with an aim to highlight the demographics, clinical and molecular characteristics of patients presenting with MPNs in one of the largest tertiary care centres in Lahore, Pakistan and to observe what differences we encounter in our daily practice as compared to published studies.

## Methodology

This cross-sectional descriptive study was conducted at Inmol Cancer Hospital Lahore from 15 November 2025 till 15 May 2026 after official approval of synopsis and ethical approval from the institute, vide reference number: IRB NO. INMOL-53-(220). A sample size of 93 patients was calculated keeping confidence level of 95%, margin of error 5% and the population proportion at 4%.[11]

Inclusion criteria: All patients diagnosed with Myeloproliferative disorders [chronic myeloid leukaemia, essential thrombocytosis, polycythaemia Vera, myelofibrosis] on the bases of WHO criteria were included in the study. Patients were from both genders.

Exclusion criteria: All children under age of 10 years were excluded from the study. Any patient with active alcohol or drug addiction, patients with missing data or lost to follow up, patients having dual malignancy, patients having accelerated or blast phase chronic myeloid leukaemia and any Myeloproliferative disorders which had transformed into AML or Myelodysplastic syndromes were excluded from the study.

All included patients were informed about the study and written consent was taken before including their data in the study.

Patients presenting in clinical haematology OPD were enrolled in the study in accordance with selection criteria. Baseline investigations including CBC, RFTs, HBA1c, Ultrasound abdomen/Pelvis, Bone marrow examination, cytogenetics and molecular profile was done. Patients were risk stratified and treatment started accordingly. Patients were followed over a period of 1 year and any complication that occurred and response to treatment was noted.

Data was analyzed using SPSS version 26. Quantitative variables i.e. Age, Hemoglobin levels, Hematocrit, MCV, MCH, TLC, and Platelets were expressed as mean ± standard deviation, while qualitative variables i.e. Gender, clinical symptoms, examination findings, molecular results, and complications were expressed as frequency and percentages.

## Results

A total of 163 patients were included in the study. Of these, 93 patients were diagnosed with Ph Chromosome negative myeloproliferative neoplasms (MPNs) and 70 patients were diagnosed with CML.

Among the 93 MPNs cases, 58 (62.4%) were males and 35 (37.6%) were females. The age of the patients ranged from 19 to 72 years, with a mean age of 46.7 ± 15.2 years. The most frequently diagnosed subtype was essential thrombocythemia (ET) in 41 (44.1%) patients, followed by myelofibrosis (MF) in 29 (31.2%) and polycythemia Vera (PV) in 23 (24.7%) cases. Table I summarizes the categorical variables of all included patients across all 3 disorders of the study. The continuous variables recorded amongst all 3 disorders are summarized in Table II.

In figure-1, all age groups are highlighted in detail for all Ph-negative MPNs at which they were first diagnosed. The majority (64.27%) of the patients fall below the age of 50 years at the time of diagnosis, with some percentage falling above the age of 60, 70, and even 80 years in the case of ET.

For CML cases, a total of 70 patients' data was included in the study. Demographic data of all patients with CML is detailed in Table III.

| Table I: Summary of Categorical Variables in Ph-negative MPN Subtypes (ET, MF, PV). (n=93) | | | | | |
|---|---|---|---|---|---|
| Variable | Category | ET n (%) | MF n (%) | PV n (%) | Total n (%) |
| Gender | Male | 19 (46.3) | 21 (72.4) | 18 (78.3) | 58 (62.4) |
| | Female | 22 (53.7) | 8 (27.6) | 5 (21.7) | 35 (37.6) |
| Fatigue | Yes | 35 (85.4) | 21 (72.4) | 12 (52.2) | 68 (73.1) |
| Weight loss | Yes | 10 (24.4) | 13 (44.8) | 10 (43.5) | 33 (35.5) |
| Pruritus | Yes | 5 (12.2) | 6 (20.7) | 3 (13.0) | 14 (15.1) |
| Abdominal distension | Yes | 4 (9.8) | 3 (10.3) | 4 (17.4) | 11 (11.8) |
| Splenomegaly | Yes | 10 (24.4) | 20 (69.0) | 11 (47.8) | 41 (44.1) |
| JAK2 mutation | Detected | 8 (19.5) | 13 (44.8) | 16 (69.6) | 37 (39.8) |
| CALR mutation | Detected | 20 (48.8) | 0 (0.0) | 3 (13.0) | 23 (24.7) |
| MPL mutation | Detected | 2 (4.9) | 6 (20.7) | 12 (52.2) | 20 (21.5) |
| Treatment | Hydroxyurea | 33 (80.5) | 13 (44.8) | 18 (78.3) | 62 (66.7) |
| | Ruxolitinib | — | 16 (55.2) | — | 29 (31.2) |
| Complications | AKI | 3 (7.3) | 3 (10.3) | 1 (4.3) | 7 (7.5) |

| Table II: Continuous Variables in Ph-negative MPN Subtypes (ET, MF, PV) (n=93) | | | | |
|---|---|---|---|---|
| Parameter | ET (n=41) Mean ± SD | MF (n=29) Mean ± SD | PV (n=23) Mean ± SD | Total (n=93) Mean ± SD |
| Age (years) | 41.39 ± 16.11 | 51.62 ± 13.21 | 50.09 ± 13.17 | 46.70 ± 15.20 |
| Hemoglobin (g/dL) | 12.91 ± 2.46 | 11.07 ± 2.78 | 16.68 ± 2.37 | 13.27 ± 3.29 |
| Hematocrit (%) | 42.77 ± 6.29 | 40.01 ± 10.63 | 56.50 ± 9.92 | 45.30 ± 10.90 |
| MCV (fL) | 84.30 ± 11.39 | 87.92 ± 17.85 | 77.32 ± 11.49 | 83.70 ± 14.20 |
| MCH (pg) | 27.29 ± 4.65 | 39.38 ± 23.26 | 22.96 ± 7.45 | 29.90 ± 15.20 |
| TLC (×10⁹/L) | 10.79 ± 4.66 | 48.46 ± 73.47 | 23.57 ± 12.41 | 25.70 ± 44.20 |
| Platelets (×10⁹/L) | 1129.71 ± 589.18 | 561.83 ± 408.87 | 602.74 ± 396.11 | 822.00 ± 561.00 |

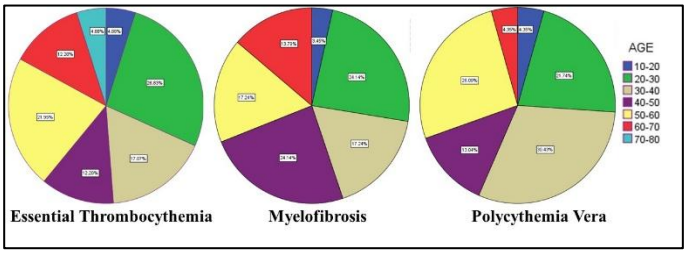



Figure 1. Age at Diagnosis (All Ph-negative MPNs), n=93

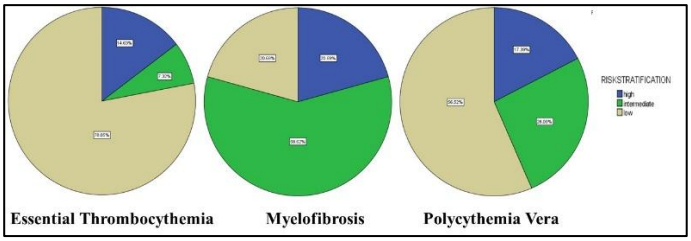



Figure 2. Risk Stratification outcomes (All Ph-negative MPNs), n=93

Distribution of patients according to age groups was done to highlight which age groups presented with CML more as compared to others. The details are shown in Figure-3

All Hematological parameters measured from peripheral venous blood samples all detailed in Table IV.

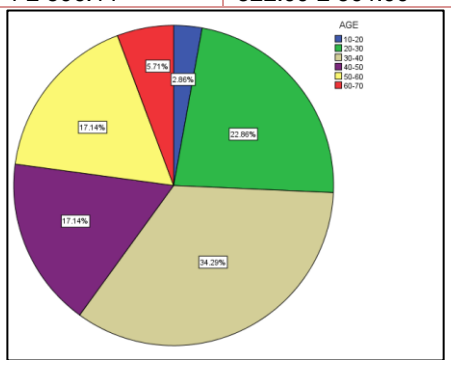



Figure 3: Age distribution of diagnosed CML cases. (n=70)

| Table III: Clinical and Pathological Characteristics of CML Patients (n = 70) | | |
|---|---|---|
| Variable | Category | n (%) |
| Gender | Male | 43 (61.4) |
| | Female | 27 (38.6) |
| Bone Marrow Blasts | <5% | 63 (90.0) |
| | >5% | 5 (7.1) |
| Bone Marrow Fibrosis Grade | Grade 0–1 | 34 (48.5) |
| | Grade 1-2 | 23 (32.8) |
| | Grade >2 | 10 (14.2) |
| | Report not found | 3 (4.3) |
| Weight Loss | Yes | 40 (57.1) |
| | No | 30 (42.9) |
| Fatigue | Yes | 56 (80.0) |
| | No | 14 (20.0) |
| Other Symptoms | Abdominal pain | 23 (32.9) |
| | Fever | 12 (17.1) |

| | | |
|---|---|---|
| | None | 25 (35.7) |
| | Others combined | 10 (14.3) |
| Splenomegaly | Present | 66 (94.3) |
| | Absent | 4 (5.7) |
| ELTS Score | Low | 56 (80.0) |
| | High | 14 (20.0) |

Table IV: Hematological indices of CML Patients (n = 70)

| Parameter | Mean ± SD | Minimum | Maximum |
|---|---|---|---|
| Hemoglobin (g/dL) | 9.78 ± 1.60 | 6.5 | 14.0 |
| WBC (×10⁹/L) | 244.29 ± 115.14 | 4.0 | 578.0 |
| Platelets (×10⁹/L) | 501.87 ± 370.53 | 26 | 2032 |
| Peripheral Blood Blasts (%) | 2.79 ± 1.99 | 0 | 10 |
| Basophils (%) | 4.66 ± 3.95 | 0 | 18 |

## Discussion

In this study, we have evaluated the clinical and molecular diagnostics of Ph-negative MPNs and CML in one of the largest cancer hospitals in Lahore, Pakistan. ET was the most frequent disorder seen in the Ph-negative MPNs followed by MF and PV. This observation is also mirrored in the findings of international registries and cohorts where details of Ph-negative MPNs are summarized.[12-15] We did observe a difference in the mean age of diagnosis of our patients as compared to other studies. Our patients presented with MPNs at a mean age of 46.7 years while in European and American studies, the median age of diagnosis of MPNs has been found to be 58-65 years.[12,13,16] South Asian population presumably presents at an earlier age with MPNs as compared to western people as observed in published studies from Pakistan and India.[17,18]

Amongst genders, a male predominance was observed in both Ph-negative MPNs and CML in our patients at 62.4 and 61.4%. However, in studies conducted over the years on MPNs have concluded either a slightly higher female predominance at 63% of cases or in a few studies an almost equal gender distribution, especially in Ph-negative MPN subtypes.[12,15,19] Fatigue and weight loss have been observed to be the most common presenting symptom amongst MPN patients followed by splenomegaly. A similar trend of presenting complaints was seen as the main constitutional symptoms of MPNs in other studies.[16,19,20] The predominance of splenomegaly seen in patients with MF and PV both is also in agreement with previous datasets describing disease burden of MPNs in low- or middle-income regions. [17,21]

We performed molecular profiling on almost all of our Ph-negative MPNs to gather more insights. While our data showed a JAK2 positivity of almost 40% in Ph-negative MPNs, international literature cites a JAK2 positivity between 55-75% across most Ph-negative MPNs.[12,14,22] CALR mutations were predominantly seen in ET while MPL mutations were higher in PV cases. On the contrary, data from studies conducted worldwide have determined CALR as being the predominant gene in ET as well as MF while MPL was seen in about 3-8% of cases.[12,15] These differences might reflect upon ethnic and geographic variations, testing limitations and smaller sample sizes.

Some studies particularly from Mayo clinic and Florence registries have observed an increased count of platelets, similar to our patients, with an association of higher thrombocytosis with CALR-positive MPNs.[12,15] Consistent with treatment guidelines, hydroxyurea remained the main drug of choice especially in ET and PV cases similar to our treatment protocols.[24,25] The second treatment option, Ruxolitinib, was mainly used in MF cases, in line with European LeukemiaNet guidelines.[25]

Amongst CML cases, some studies from south Asia, such as one from Pakistan as well as another from Bangladesh have reported a male predominance at a frequency of 58% and 67%, respectively. These studies also reported a younger age at presentation i.e. at 36.6 and 37.4 years respectively, similar to our data which showed a male predominance at 62.4% and a mean age of diagnosis at 46 years. However, international data differs in observing a mean age of presentation at 55-64 years.[27,28] Fatigue and weight loss remain the most common complaints in the out-patient clinic when the patients first presented, mirroring the chronic phase presentation of CML as observed widely. [27,29] Ph-positivity seen at 97% in our setup was quite consistent with reported rates of 95-99% positivity in CML cases. [29,30] Important to mention here are some different cytogenetic abnormalities detected in our patients including trisomy 8 (+8) and additional derivative of chromosome 22 [+der$^{22}$], detected in 1 patient each. These abnormalities are not unheard of and have been mentioned as secondary cytogenetic events in various studies where they have been said to lead to a poorer diagnosis.[28,29] The markedly high levels of leukocytes and platelets in CML patients is quite in

agreement with international data where similar haematological abnormalities have been observed at the time of CML diagnosis.[27,29]

LIMITATION: This study has certain limitations that should be acknowledged. The relatively small sample size and single-center design may limit the generalizability of the findings to other settings. Additionally, long-term follow-up of patients could not be carried out, which could have provided further insight into treatment outcomes. Despite these limitations, the study offers valuable local data on MPNs in patients from Pakistan.

## Conclusion

This study reflects the epidemiological data of myeloproliferative neoplasms in Pakistan. Studies like these provide a foundation for future multicenter studies and may provide future directions on guiding more personalized diagnostics as well as therapeutic approaches in resource-poor settings. The majority of MPNs have demonstrated a distinct pattern with a younger age of presentation and significant molecular associations. The variations with Western data emphasize regional variability and need for improved diagnostics.

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