Section: Miscellaneous

Original Research Article

SPECTRUM OF ACUTE AND CHRONIC LEUKEMIA AT A TERTIARY CARE HOSPITAL IN EASTERN INDIA

Avinash Priyadarshi[1], Ankur Priyadarshi[2], Anjani Kaushal[1], Sadaf Tanweer[3], Ranesh Balajee[3], Sharad[4], Sanjay Kumar[5]

[1]Associate Professor, Department of Pathology, Mata Gujri Memorial Medical College, Kishanganj, Bihar, India
[2]Associate Professor, Department of Paediatrics, Jawaharlal Nehru Medical College, Bhagalpur, Bihar, India
[3]Tutor, Department of Pathology Mata Gujri Memorial Medical College, Kishanganj, Bihar, India
[4]Tutor, Department of Ophthalmology, Mata Gujri Memorial Medical College, Kishanganj, Bihar, India
[5]Professor, Department of Pathology, Mata Gujri Memorial Medical College, Kishanganj, Bihar, India

Received : 27/03/2025
Received in revised form : 23/05/2025
Accepted : 11/06/2025

Keywords:
Leukemia, acute leukemia, chronic leukemia, hematology, tertiary care hospital.

Corresponding Author:
Dr. Avinash Priyadarshi,
Email: avinashpriyadarshi17@gmail.com

DOI: 10.47009/jamp.2025.7.3.194

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (3); 1002-1010

ABSTRACT

Background: Leukemia is a significant hematological malignancy globally, accounting for 2.8% of all cancers and varying in prevalence and subtype distribution across regions. It is critical to understand the patterns of leukemia to guide diagnostic and therapeutic strategies. Acute leukemias, such as Acute Lymphoblastic Leukemia (ALL) and Acute Myeloid Leukemia (AML), are more prevalent in children and adults respectively, while chronic leukemias like Chronic Myeloid Leukemia (CML) and Chronic Lymphocytic Leukemia (CLL) are primarily adult diseases. The study aims to analyze the clinical, hematological, and morphological characteristics of leukemia cases, evaluate gender and age group distribution, and identify the most prevalent leukemia subtypes at a tertiary care hospital. **Materials and Methods:** This retrospective study analyzed 68 leukemia cases diagnosed between May 2023 and April 2024 at a tertiary care teaching hospital. Data were collected through detailed medical histories, clinical examinations, complete blood counts, and morphological assessments using peripheral blood and bone marrow aspiration smears. Cytochemical staining techniques, such as Myeloperoxidase (MPO) and Periodic Acid-Schiff (PAS), were employed for further subtype classification based on the WHO and FAB criteria. **Result:** Out of 68 cases, acute leukemias comprised 67.64%, while chronic leukemias constituted 32.36%. Among the acute leukemias, ALL was the most prevalent subtype (35.29%), followed by AML (32.35%). Chronic leukemia cases were dominated by CML (23.53%), with CLL being the least common (8.82%). A pronounced male predominance was observed, with an overall male-to-female ratio of 3.85:1. The most affected age groups were 0–10 years for ALL (23.52%), 31–40 years for AML (10.29%), and 41–50 years for CML (7.35%). **Conclusion:** The study highlights the predominance of acute leukemias, particularly ALL, in the regional population, with chronic leukemias being less common. The findings emphasize the importance of comprehensive hematological and cytochemical analysis for accurate diagnosis and effective management of leukemia cases in this setting.

INTRODUCTION

The rationale for this study stems from the need to bridge knowledge gaps in the regional epidemiology and clinical presentation of leukemia. While global and national studies have provided insights into leukemia patterns, regional variations are often overlooked, leading to gaps in tailored healthcare planning. This study focuses on addressing these gaps by investigating the specific patterns of leukemia cases within the institution, reflecting the unique demographic and environmental influences of the region.

Furthermore, the tertiary care hospital serves as a referral center for a diverse population, encompassing both urban and rural communities. This provides a unique opportunity to capture a wide spectrum of leukemia cases, which may differ significantly from those reported in other regions or institutions. By systematically analyzing clinical,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

hematological, and morphological features, the study seeks to identify potential diagnostic challenges, such as atypical presentations or underreported subtypes, and contribute to improving early diagnosis and management.

In addition, understanding gender and age-related trends in leukemia incidence is crucial for anticipating future healthcare needs and allocating resources effectively. For example, a higher prevalence of pediatric ALL would necessitate investments in pediatric oncology services, while an increased burden of CML or CLL in older adults would highlight the need for geriatric oncology expertise and access to targeted therapies.

Ultimately, this study aims to provide a robust dataset that can serve as a foundation for further research and healthcare planning. By identifying prevalent subtypes and demographic trends, it seeks to enhance diagnostic accuracy, guide treatment protocols, and inform regional health policies for better leukemia management.

Objective of the Study

Leukemia, a heterogeneous group of hematological malignancies, represents a significant global and regional healthcare burden due to its varying incidence and clinical presentation across populations. Understanding its patterns within a specific geographical or institutional context is critical for guiding diagnostic, therapeutic, and policy decisions. The objectives of this study are aligned with addressing these needs in the context of a tertiary care hospital.

The primary objective of this study is to evaluate the spectrum of leukemia cases based on their clinical, hematological, and morphological characteristics. Leukemia subtypes, including Acute Myeloid Leukemia (AML), Acute Lymphoblastic Leukemia (ALL), Chronic Myeloid Leukemia (CML), and Chronic Lymphocytic Leukemia (CLL), exhibit diverse clinical presentations and laboratory findings, which are influenced by genetic, environmental, and demographic factors. Analyzing these characteristics will provide a comprehensive understanding of the disease patterns specific to this institution and its patient population.

A secondary but equally important objective is to analyze the distribution of leukemia cases across different gender and age groups. Existing literature indicates variations in leukemia prevalence and subtype distribution between males and females, as well as across different age cohorts, with acute leukemias often dominating in pediatric and younger adult populations, while chronic leukemias are more common in older individuals. Identifying these trends within the study population will help to delineate demographic predispositions and inform tailored healthcare strategies.

Additionally, the study aims to determine the most prevalent types of leukemia diagnosed at the hospital. This aspect of the study is particularly relevant in regions with limited healthcare infrastructure, where understanding the predominant leukemia subtypes can facilitate the prioritization of diagnostic resources and the development of disease-specific treatment protocols. Such insights are critical for addressing the challenges posed by late diagnosis, resource constraints, and disparities in access to specialized care.

Review of Literature

Global Burden and Significance of Leukemia

Leukemia represents a significant global health challenge, being a major contributor to cancer-related morbidity and mortality. In 2018, leukemia was identified as the 11th leading cause of cancer deaths worldwide, with an incidence rate of approximately 3.4% among all cancers and a mortality rate of 3.8%.[1] The disease accounted for an estimated 0.52 million new cases and 0.35 million deaths globally in 2017, highlighting its persistent prevalence despite advancements in treatment. This malignant hematological condition not only imposes a substantial personal and familial burden but also has significant implications for national healthcare systems and economies, particularly in low- and middle-income countries where access to advanced diagnostics and therapeutics remains limited.

Leukemia displays regional, age-related, and subtype-specific variations in prevalence. While acute lymphoblastic leukemia (ALL) is the most common malignancy in children, chronic lymphocytic leukemia (CLL) is predominantly observed in the elderly population. The global burden shows a bimodal distribution, with the highest incidence rates in early childhood and late adulthood.[1] Disparities in survival outcomes are evident, with high-income countries benefiting from advanced therapeutic strategies such as targeted therapies and immunotherapy. However, in resource-constrained settings, delayed diagnosis and suboptimal treatment contribute to higher mortality rates. Male predominance in leukemia incidence further underscores the need to investigate gender-specific risk factors. Addressing these gaps requires an integrated approach, combining improved healthcare infrastructure, early detection programs, and equitable access to emerging therapies, to mitigate the global burden of leukemia effectively.[2]

In addition to its widespread prevalence, leukemia's impact is exacerbated by the diverse challenges posed by its subtypes and associated risk factors. Acute myeloid leukemia (AML) and acute lymphoblastic leukemia (ALL) together account for the majority of leukemia-related deaths. AML primarily affects adults and often exhibits poor prognosis despite intensive treatment regimens, while ALL remains the leading cause of cancer-related mortality in children globally, amplifying the disease's familial and societal impact.[3] Chronic subtypes like chronic myeloid leukemia (CML) have benefited from significant advancements, such as the introduction of tyrosine kinase inhibitors, which have markedly improved survival rates. However, chronic lymphocytic leukemia (CLL), which is more common in older adults, remains challenging to

ISSN (O): 2687-5365; ISSN (P): 2753-6556

manage, particularly in regions with limited healthcare access.[1,2]

The socioeconomic and environmental determinants of leukemia further compound its global burden. Modifiable risk factors such as smoking, high body mass index (BMI), and exposure to carcinogens like benzene and formaldehyde have been significantly associated with leukemia incidence and mortality.[2,3] These risks are particularly pronounced in low- and middle-income countries, where occupational exposures and limited regulatory controls on environmental toxins exacerbate the disease burden. Moreover, disparities in healthcare infrastructure and accessibility result in delayed diagnoses and suboptimal treatment outcomes, disproportionately affecting vulnerable populations.[1] Collectively, these factors underscore the urgent need for targeted interventions, including public health education, policy reforms to reduce carcinogen exposure, and the development of cost-effective diagnostic and therapeutic modalities, to address the global challenges posed by leukemia effectively.

Acute vs. Chronic Leukemia and Their Respective Subtypes

Classification of Leukemia

Leukemia, a malignancy of hematopoietic cells, is classified into acute and chronic forms based on the rate of disease progression and the maturity of the affected hematopoietic cells. Acute leukemia is characterized by the rapid proliferation of immature blast cells, resulting in bone marrow failure and the replacement of normal hematopoietic elements. Chronic leukemia, in contrast, progresses more slowly, with the accumulation of mature, but dysfunctional, hematopoietic cells. This fundamental classification underpins the diagnostic, therapeutic, and prognostic strategies employed in managing leukemia.[4]

Acute Leukemia

Definition and Subtypes: Acute leukemia includes two main subtypes: acute lymphoblastic leukemia (ALL) and acute myeloid leukemia (AML). ALL is predominantly observed in pediatric populations, accounting for 75% of childhood leukemia cases globally. It is closely associated with specific chromosomal abnormalities, such as the t(12;21) translocation, which has implications for prognosis.[3] Conversely, AML is more common in adults and is characterized by significant genetic heterogeneity, with recurrent mutations like FLT3-ITD and NPM1 playing pivotal roles in influencing disease progression and treatment outcomes.[4]

Clinical Features and Diagnosis: Patients with acute leukemia often present with clinical features of bone marrow failure, including anemia, thrombocytopenia, and neutropenia, alongside systemic symptoms such as fever and weight loss. Organ infiltration by leukemic cells can lead to additional complications, including lymphadenopathy and hepatosplenomegaly. Diagnostic confirmation requires identifying ≥20% blasts in bone marrow or peripheral blood, as per WHO guidelines. Subtyping relies on a combination of immunophenotyping, cytogenetic, and molecular studies, which also guide therapeutic decisions.[5]

Advancements in Management: Recent advances, including next-generation sequencing and targeted therapies, have enhanced the identification of prognostic markers, enabling personalized therapeutic approaches. Despite these advancements, global disparities persist, with survival rates significantly lower in low- and middle-income countries due to limited access to timely diagnosis and treatment.[3]

Chronic Leukemia

Definition and Subtypes: Chronic leukemia is typified by the gradual accumulation of mature, but functionally impaired, white blood cells. The two primary subtypes are chronic lymphocytic leukemia (CLL) and chronic myeloid leukemia (CML). CLL, the most common leukemia in adults in Western populations, arises from the clonal proliferation of mature B lymphocytes and is often associated with genetic aberrations such as del(17p) and unmutated IGHV genes.[6] In contrast, CML is characterized by the presence of the Philadelphia chromosome, resulting in the BCR-ABL1 fusion protein, which drives leukemic proliferation.[4]

Clinical Course: The clinical behavior of chronic leukemia varies by subtype. CLL typically follows an indolent course but can progress rapidly in the presence of high-risk genetic markers. Clinical manifestations include lymphadenopathy, hepatosplenomegaly, and immunological disturbances, such as hypogammaglobulinemia.[6] CML progresses through distinct phases: chronic, accelerated, and blast crisis, with disease trajectory influenced by the acquisition of additional genetic mutations during progression.[5]

Advancements in Management: The advent of tyrosine kinase inhibitors (TKIs) has revolutionized the treatment of CML, transforming it into a manageable chronic condition for many patients. However, the treatment of CLL remains complex, particularly in cases with high-risk cytogenetic profiles. Advances in molecular diagnostics have facilitated better risk stratification and the development of novel therapeutic strategies.[4,6]

Clinical and Diagnostic Importance

Leukemia encompasses a spectrum of hematological malignancies characterized by abnormal proliferation of hematopoietic cells, leading to bone marrow failure and systemic manifestations. Acute leukemia often presents with sudden and severe symptoms such as anemia, thrombocytopenia, and leukocytosis, whereas chronic leukemia has an indolent course and is frequently discovered incidentally. These clinical differences underline the necessity for distinct diagnostic approaches for acute and chronic leukemias.[7,8]

The diagnostic process begins with a detailed clinical assessment, supported by hematological studies such as complete blood count (CBC) and peripheral blood smear examination. Acute leukemias are defined by

ISSN (O): 2687-5365; ISSN (P): 2753-6556

the presence of ≥20% blasts in the bone marrow or peripheral blood, as per the World Health Organization (WHO) criteria. Bone marrow aspiration and biopsy are central to the diagnosis and subtyping of leukemia, revealing morphologic and cytochemical characteristics such as myeloperoxidase (MPO) positivity in acute myeloid leukemia (AML) and periodic acid-Schiff (PAS) positivity in acute lymphoblastic leukemia (ALL).[7,9] Advanced diagnostic tools, including immunophenotyping and cytogenetic analyses, are critical for confirming the lineage of leukemia and identifying prognostic markers. Immunophenotyping uses monoclonal antibodies to detect specific cell surface antigens, aiding in distinguishing between myeloid and lymphoid origins. This technique has transformed the diagnostic landscape by allowing precise subtyping and revealing cases where morphological and cytochemical findings are inconclusive or conflicting.[9] Cytogenetic studies, such as the detection of the Philadelphia chromosome in chronic myeloid leukemia (CML) or t(12;21) translocation in ALL, provide essential prognostic information and guide targeted therapies.[4,7]

Molecular diagnostics, including next-generation sequencing (NGS), further enhance the precision of leukemia classification by identifying genetic mutations and aberrations associated with various subtypes. For example, mutations in NPM1 and FLT3-ITD in AML have significant implications for prognosis and treatment decisions. Similarly, high-risk genetic markers such as del(17p) in chronic lymphocytic leukemia (CLL) predict aggressive disease courses and inform treatment strategies.[6,10]

The integration of morphological, cytochemical, immunophenotypic, and molecular diagnostic modalities ensures accurate classification and prognosis, which are crucial for effective leukemia management. These diagnostic advancements enable personalized treatment approaches, such as tyrosine kinase inhibitors for CML and immunotherapy for ALL, significantly improving patient outcomes.[4,7,8]

Regional variations in leukemia patterns.

Leukemia, a heterogeneous group of hematologic malignancies, exhibits significant regional variability influenced by genetic predispositions, environmental factors, and healthcare disparities. Globally, leukemia ranks as the tenth most common cancer, comprising 2.8% of all malignancies, with marked differences in subtype prevalence between regions. Acute leukemias tend to be more prevalent in low- and middle-income countries (LMICs), while chronic leukemias dominate in high-income countries (HICs) due to advancements in early diagnosis and therapeutic interventions.[11,12]

Acute Myeloid Leukemia (AML) is the most prevalent acute leukemia among adults in developed regions, including North America, Western Europe, and Oceania, accounting for 80% of all acute leukemia cases in adults. Its incidence increases with age, peaking in individuals over 60 years old. In India, AML demonstrates a broader age distribution, with cases reported from childhood to older adulthood, reflecting regional variations in age-related risk factors.[11] Acute Lymphoblastic Leukemia (ALL), predominantly affecting children, has its highest incidence in North America but is less prevalent in South and Central India. This discrepancy may be related to genetic predispositions and early-life environmental exposures, such as infections and dietary factors, which are known to influence ALL risk.[11]

Chronic Myeloid Leukemia (CML) exhibits unique regional patterns, with India reporting a median diagnosis age approximately a decade younger than that in Western countries. This younger onset may be linked to genetic factors and lifestyle influences. CML constitutes 77% of chronic leukemia cases in Indian studies, underscoring its prominence among hematologic malignancies in the region.[11] In HICs, the introduction of tyrosine kinase inhibitors has revolutionized CML management, transforming it into a chronic, manageable disease. However, access to such advanced treatments remains limited in LMICs, contributing to higher mortality rates and disease burden in these regions.[12]

Chronic Lymphocytic Leukemia (CLL) is the most common leukemia among elderly populations in Western countries, accounting for approximately 30% of all leukemia cases. However, its prevalence in India is significantly lower, representing only 2–4% of all leukemia cases.[11] This disparity may be due to genetic variations, underdiagnosis, or misclassification in resource-constrained settings. Environmental and lifestyle factors, such as smoking and obesity, also contribute significantly to the burden of CLL in developed countries.[12]

Socioeconomic disparities heavily influence leukemia patterns across regions. High-SDI (Socio-Demographic Index) countries have achieved substantial reductions in leukemia-related mortality through early detection and access to advanced therapies.[13] Meanwhile, low-SDI regions, including parts of India and Sub-Saharan Africa, face increasing leukemia incidence due to delayed diagnosis, lack of modern treatment modalities, and inadequate healthcare infrastructure. For example, while India reports the highest absolute number of CML cases globally, its age-standardized incidence rate remains lower than that of HICs, reflecting the dual challenge of underreporting and limited healthcare access.[12]

Indian Context: Within India, the epidemiology of leukemia demonstrates significant regional heterogeneity, influenced by demographic, environmental, and socio-economic factors. Understanding these intra-national patterns provides critical insights for tailoring healthcare interventions and addressing the burden of hematologic malignancies across the country.

Acute Leukemias in Different Regions of India: Acute leukemias, particularly Acute Myeloid Leukemia (AML) and Acute Lymphoblastic Leukemia (ALL), exhibit regional variations across

ISSN (O): 2687-5365; ISSN (P): 2753-6556

India. AML, which is more common in adults, accounts for the majority of acute leukemia cases in hospital-based studies in Northern India. In this region, factors such as pesticide exposure and industrial pollution have been hypothesized to contribute to the high incidence. The Malwa region of Punjab, for example, has reported elevated cancer rates, including hematologic malignancies, linked to agricultural pesticide use and groundwater contamination with heavy metals like uranium.[13]

In contrast, ALL, which predominantly affects children, has been extensively studied in regions like Northeast India. Here, ALL constitutes 19.3% of all childhood cancers, with a male predominance.[14] The prevalence of high-risk cytogenetic subtypes, such as t(9;22) and hypodiploidy, is notable in this region, potentially influencing treatment outcomes and survival rates. Socioeconomic challenges, including delayed diagnosis and limited access to specialized pediatric oncology services, exacerbate the burden of ALL in these areas.[14]

Eastern India, including Varanasi and surrounding districts, has shown a similar pattern of acute leukemia predominance, with AML affecting both children and adults. Hospital-based studies indicate that acute leukemias account for 66.3% of all leukemia cases in the region, with a male-to-female ratio of 1.9:1. Common clinical presentations include fever, generalized weakness, and pallor, while anemia and thrombocytopenia are more severe in acute cases.[15] These findings underscore the need for improved diagnostic and therapeutic facilities in this region to manage the high burden of acute leukemias.

Southern India, on the other hand, has contributed significantly to cytogenetic studies of leukemia. Data from institutions like the Tata Memorial Hospital in Mumbai reveal distinct genetic profiles of acute leukemias. The prevalence of favorable chromosomal translocations, such as t(8;21) and t(15;17), is higher in Southern India compared to other parts of the country, suggesting geographic heterogeneity in genetic predisposition. These translocations are associated with better prognosis and response to targeted therapies, highlighting the importance of cytogenetic analysis in treatment planning.[16]

Chronic Leukemias in India: Chronic Myeloid Leukemia (CML) shows notable regional variations within India. Studies from North India report a higher prevalence of CML among younger adults, with the median age of diagnosis being around 40 years—significantly younger than in Western populations. This younger age of onset may be attributed to genetic factors, lifestyle influences, and environmental exposures specific to the region. Furthermore, the prevalence of CML in rural and semi-urban areas often goes underreported due to inadequate healthcare access and awareness.[11]

In contrast, Chronic Lymphocytic Leukemia (CLL) is less commonly diagnosed in India compared to Western countries. Hospital-based data suggest that CLL accounts for only 2–4% of all leukemia cases in India, with a higher prevalence in urban centers where diagnostic facilities are more accessible. The lower incidence of CLL in rural areas may be partially explained by underdiagnosis or misclassification, as well as genetic differences between Indian and Western populations.[17] Additionally, lifestyle factors such as smoking and obesity, which are significant risk factors for CLL in developed nations, may have a different impact in the Indian context.

Cytogenetic and Environmental Influences: Cytogenetic studies in India reveal regional disparities in the prevalence of chromosomal abnormalities associated with leukemia. For example, translocations like t(8;21) and t(15;17) are more prevalent in AML patients from Southern India, while unfavorable cytogenetic markers, such as complex karyotypes and deletions of chromosomes 5 and 7, are observed more frequently in certain industrialized regions.[16] These findings highlight the role of environmental exposures, such as industrial pollutants and radiation, in shaping the genetic landscape of leukemia across the country.

Regions with high agricultural activity, such as Punjab and Haryana, have reported an increased incidence of leukemia linked to pesticide exposure. Studies indicate that chronic exposure to organophosphates and other agrochemicals may contribute to the development of hematologic malignancies by inducing genetic mutations and chromosomal aberrations.[13] Similarly, groundwater contamination with heavy metals in parts of Western and Northern India has been associated with a higher prevalence of leukemia, underscoring the importance of addressing environmental risk factors.

Socioeconomic Disparities and Healthcare Access: The disparities in leukemia patterns across India are further exacerbated by socioeconomic factors. In urban centers like Mumbai and Delhi, access to advanced diagnostic and therapeutic facilities has led to better outcomes for leukemia patients. However, in rural and semi-urban areas, delayed diagnosis and limited access to specialized care result in poorer survival rates. For instance, while tyrosine kinase inhibitors have transformed CML management in urban hospitals, their availability and affordability remain a challenge in resource-limited settings.[12]

The lack of standardized cancer registries and underreporting of cases in rural areas also hinder a comprehensive understanding of leukemia epidemiology in India. Efforts to improve cancer surveillance, along with investments in healthcare infrastructure, are critical to bridging these gaps and addressing regional disparities in leukemia care.

MATERIALS AND METHODS

Study Design and Setting: This was a retrospective observational study conducted at a tertiary care teaching hospital, aimed at evaluating the spectrum

ISSN (O): 2687-5365; ISSN (P): 2753-6556

and distribution of leukemia cases over a defined period.

Study Period

The study was carried out over a period of one year, from May 2023 to April 2024.

Sample Size

A total of 68 cases of leukemia were included in the study based on defined inclusion and exclusion criteria.

Inclusion Criteria

- Patients of all age groups and both genders diagnosed with leukemia.
- Diagnosis established based on morphological, cytochemical, and hematological criteria in accordance with World Health Organization (WHO) classification.

Exclusion Criteria

- Cases with incomplete clinical or laboratory records.
- Cases with unclear or inconclusive diagnosis.

Diagnostic Approach

Each case was subjected to a standard diagnostic protocol comprising:

- Complete blood counts performed using automated hematology analyzers.
- Peripheral smear examination to assess morphological characteristics.
- Bone marrow aspiration to evaluate marrow cellularity and blast percentage.
- Cytochemical staining, including:
- Myeloperoxidase (MPO) for myeloid differentiation.
- Periodic Acid-Schiff (PAS) staining for lymphoid lineage confirmation.

Diagnosis of acute leukemia was based on WHO criteria, with a blast threshold of ≥20% in the bone marrow. Further subtyping of acute leukemia cases was done using the French-American-British (FAB) classification system.

Data Collection and Analysis

Relevant clinical and laboratory data were extracted from hospital records. Descriptive statistics were used to analyze demographic distribution, leukemia subtypes, and age-gender trends. Data were compiled and analyzed using Microsoft Excel and SPSS (Statistical Package for the Social Sciences) software.

RESULTS

A total of 68 cases of leukemia were diagnosed over a 12-month period, from May 2023 to April 2024. Among these, acute leukemias constituted the majority, with 46 cases (67.64%), while chronic leukemias accounted for 22 cases (32.36%) [Table 1].

Table 1: Percentage of acute/ chronic leukemias.

Type of leukemia	Total no. of cases	Percentage
Acute leukemia	46	67.64%
Chronic leukemia	22	32.36%
Total	68	100%

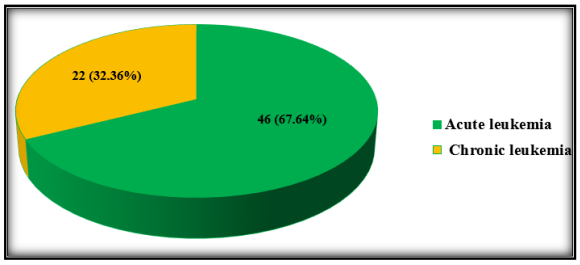

Figure 1: Percentage of Acute vs Chronic Leukemia

Subtype Distribution: Of the acute leukemia cases, acute lymphoblastic leukemia (ALL) was the most frequently encountered subtype, observed in 24 patients (35.29%), followed closely by acute myeloid leukemia (AML) in 22 patients (32.35%). Among chronic leukemias, chronic myeloid leukemia (CML) was predominant, diagnosed in 16 cases (23.53%), while chronic lymphocytic leukemia (CLL) was the least common, with 6 cases (8.82%) [Table 2].

Table 2: Prevalence of different types of acute/ chronic leukemias.

Type of leukemia	Total no. of cases	Percentage
ALL	24	35.30%
AML	22	32.35%
CML	16	23.53%
CLL	06	08.82%
Total	68	100%

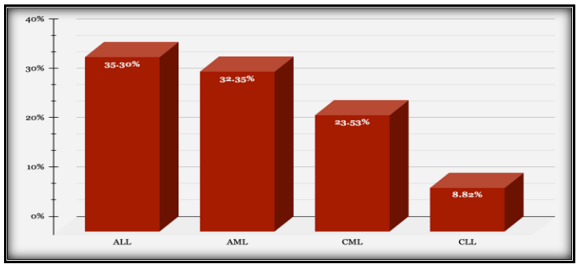

Figure 2: Percentage of Prevalence of Different Types of Acute & Chronic Leukemia

Gender Distribution: A marked male predominance was evident across all leukemia types. Out of the 68 cases, 54 were male (79.41%) and 14 were female (20.59%), resulting in a male-to-female ratio of 3.85:1 [Table 3]. Gender-wise analysis across subtypes revealed that:

- ALL occurred in 16 males and 8 females,
- AML in 17 males and 5 females,
- CML in 15 males and 1 female, and
- CLL as exclusively observed in males (6 cases).

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 3: Sex wise distribution

Male	54 (79.41%)
Female	14 (20.59%)
Total	68 (100%)

Table 4: Gender distribution among types of Leukaemia

Type of leukemia	Male	Female	Total
ALL	16 (23.52%)	08 (11.76%)	24 (35.29%)
AML	17(25.00%)	05 (7.35%)	22(32.35%)
CML	15 (22.05%)	01 (1,47%)	16 (23.52%)
CLL	06 (8.82%)	00 (00%)	06 (8.82%)
Total	54 (79.41%)	14 (20.58%)	68 (100%)

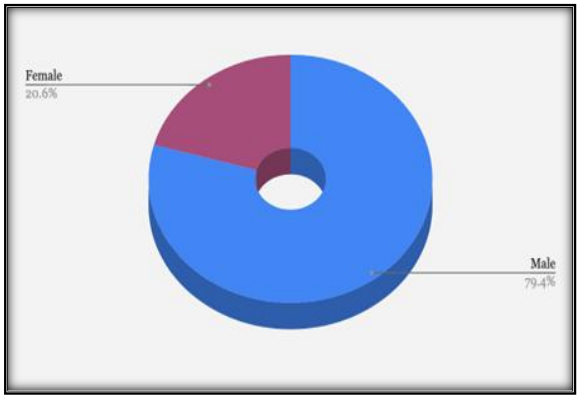

Figure 3: Sex wise distribution of occurrence of Leukemias

Age Distribution: Age-wise distribution showed that the 0–10 years age group was the most affected overall, comprising 25% of all cases. Subtype-specific trends revealed that:

- ALL was most prevalent in the 0–10 years group, with 16 cases (23.52%),
- AML was most frequent in the 31–40 years group, accounting for 7 cases, and
- CML was predominant in the 41–50 years group, with 5 cases.
- CLL was primarily seen in older adults, especially in the 61–70 years age group (3 cases)

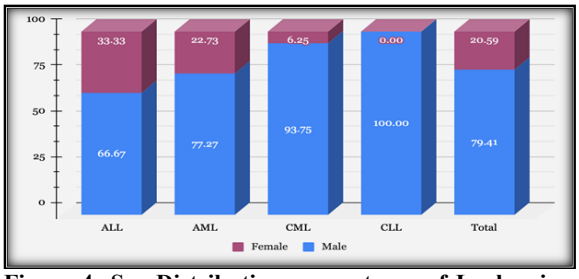

Figure 4: Sex Distribution across types of Leukemias (%)

Table 5: Distribution of cases of leukemia in various age groups.

Age	ALL	AML	CML	CLL	Total
0-10yrs.	16(23.52%)	01(1.47%)	00	00	17(25.00%)
11-20yrs	04(5.88%)	01(1.47%)	00	00	05(7.35%)
21-30yrs.	03(4.41%)	03(4.41%)	01(1.47%)	00	07(10.29%)
31-40yrs.	01(1.47%)	07(10.29%)	03(4.41%)	00	11(16.17%)
41-50yrs.	00	04(5.88%)	05(7.35%)	01(1.47%)	10(14.70%)
51-60yrs	00	03(4.41%)	04(5.88%)	01(1.47%)	08(11.76%)
61-70yrs.	00	02(2.94%)	02(2.94%)	03(4.41%)	07(10.29%)
>70yrs.	00	01(1.47%)	01(1.47%)	01(1.47%)	03(4.41%)
Total	24(35.29%)	22(32.35%)	16(23.52%)	06(8.82%)	68(100%)

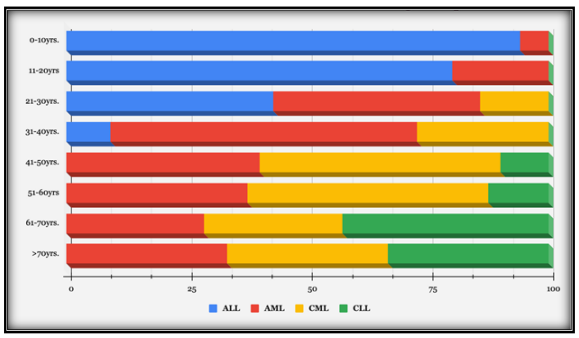

Figure 5: Age Distribution across different types of Leukemias

Cytochemical Findings

Cytochemical staining was instrumental in confirming leukemia subtypes:

All AML cases (n=22) showed strong positivity for Myeloperoxidase (MPO), while being negative for Periodic Acid-Schiff (PAS).

Conversely, ALL cases (n=24) were PAS-positive and negative for MPO, in accordance with established cytochemical profiles.

Table 6: Distribution of Cases of Cytochemical Staining in AML and ALL

Leukemia Type	Myeloperoxidase (MPO)	Periodic Acid-Schiff (PAS)
AML	Positive (n=22)	Negative
ALL	Negative	Positive (n=24)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

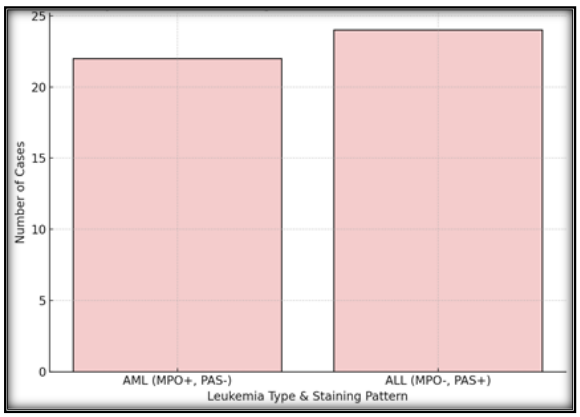

Figure 6: Cytochemical Staining Patterns in AML and ALL Cases

DISCUSSION

Key Findings: In this hospital-based retrospective study, acute leukemias were found to be the most prevalent hematological malignancies, accounting for 67.64% of the total cases. Among the subtypes, acute lymphoblastic leukemia (ALL) was the most frequently diagnosed (35.29%), followed closely by acute myeloid leukemia (AML) (32.35%). Chronic leukemias constituted 32.36% of the cases, with chronic myeloid leukemia (CML) being the predominant chronic subtype. A marked male predominance was observed across all leukemia types, with a male-to-female ratio of 3.85:1. Age distribution revealed subtype-specific patterns: ALL was most common in children (0–10 years), AML in young adults (31–40 years), and CML in middle-aged individuals (41–50 years). CLL remained the rarest subtype, identified in only 6 cases (8.82%).

Comparison with Existing Literature

The predominance of acute leukemias observed in this study aligns with several Indian studies, including those by D'Costa, Kulshrestha, and Modak (18-20), which also reported a higher incidence of acute leukemias compared to chronic types. These findings contrast with Western literature, where chronic leukemias—particularly CLL—are often more prevalent.

The higher frequency of ALL over AML in our cohort corresponds with findings from Rego,[21] but differs from studies by Modak. and Chen,[20,22] who identified AML as the dominant subtype. In contrast, CML was the leading chronic leukemia in our setting, corroborating results from D'Costa and Kulshrestha,[18,19] but differing from Western patterns, where CLL is more frequent among adults.

Our observed male predominance is consistent with the findings of Harani MS, Ullah K, and Salkar AB (23-25), who reported male-to-female ratios ranging from 1.5:1 to 2:1. However, the ratio in our study (3.85:1) is notably higher than those reported in other regional and international studies, including Gupta R(1.94:1).[26]

Potential Explanations: The predominance of acute leukemias, particularly ALL in children, may be attributed to a combination of genetic predispositions, environmental exposures, and early-life immunological factors. Regional variations in the incidence of AML and CML might reflect differences in diagnostic capacity, referral patterns, and occupational or environmental exposures, such as pesticides and industrial pollutants, which have been highlighted in Indian studies.

The male predominance could be influenced by both biological factors, such as hormonal or chromosomal susceptibility, and sociocultural factors, including gender bias in healthcare access, particularly in rural or underserved populations.

Implications: These findings have significant implications for regional healthcare planning. The high burden of pediatric ALL necessitates strengthening pediatric oncology services, while the adult predominance of AML and CML calls for expanded hematology and molecular diagnostic infrastructure. Early diagnosis and appropriate subtype classification remain critical for optimizing treatment outcomes and resource utilization in tertiary care settings.

Strengths and Limitations: Strengths of this study include the application of comprehensive diagnostic methods, including cytochemical staining, and the detailed demographic analysis of leukemia subtypes in a real-world tertiary care context. However, several limitations must be acknowledged: the retrospective design, single-center scope, and relatively small sample size may limit the generalizability of the findings. Furthermore, lack of immunophenotyping and cytogenetic data precluded detailed molecular classification.

CONCLUSION

This retrospective study provides critical insights into the spectrum of leukemia at a tertiary care center, emphasizing the predominance of acute leukemias (67.64%), with acute lymphoblastic leukemia (ALL) being the most frequent subtype, particularly among pediatric patients. Chronic leukemias accounted for 32.36% of cases, with chronic myeloid leukemia (CML) as the leading subtype. The data also highlight a notable male predominance (male-to-female ratio: 3.85:1) and distinct age-related trends, such as the prevalence of ALL in children, AML in young adults, and CML in middle-aged individuals.

The findings underscore the importance of early diagnosis and precise subtype classification, which are pivotal for implementing effective treatment protocols and improving patient outcomes. Cytochemical staining methods (e.g., MPO and PAS) remain valuable diagnostic tools in resource-limited settings, aiding in morphological differentiation when advanced molecular techniques are unavailable.

Given the regional epidemiological patterns observed, this study advocates for the expansion of diagnostic infrastructure, especially in under-

ISSN (O): 2687-5365; ISSN (P): 2753-6556

resourced settings, to facilitate timely and accurate leukemia diagnosis. Furthermore, the data emphasize the need for targeted healthcare investments, such as pediatric oncology services and adult hematology programs, tailored to the demographic burden.

To build upon these findings, future multicenter studies with larger sample sizes and incorporation of immunophenotypic and molecular data are recommended. Such research will help refine our understanding of leukemia subtypes, regional risk factors, and therapeutic responses, ultimately informing national health policies and resource allocation strategies for optimal leukemia management.

REFERENCES

1. Lin X, Wang J, Huang X, et al. Global, regional, and national burdens of leukemia from 1990 to 2017: a systematic analysis of the global burden of disease 2017 study. Aging (Albany NY). 2021;13(7):10468–10489. doi:10.18632/aging.202809
2. Global Burden of Disease Cancer Collaboration. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. JAMA Oncol. 2017;3(4):524–548. doi:10.1001/jamaoncol.2016.5688
3. Du M, Chen W, Liu K, et al. The global burden of leukemia and its attributable factors in 204 countries and territories: findings from the Global Burden of Disease 2019 Study and projections to 2030. J Oncol. 2022;2022:1612702. doi:10.1155/2022/1612702
4. Jalte M, Abbassi M, El Mouhi H, Daha Belghiti H, Ahakoud M, Bekkari H. FLT3 mutations in acute myeloid leukemia: unraveling the molecular mechanisms and implications for targeted therapies. Cureus. 2023;15(9):e45765. doi:10.7759/cureus.45765
5. Vetrie D, Helgason GV, Copland M. The leukaemia stem cell: similarities, differences and clinical prospects in CML and AML. Nat Rev Cancer. 2020;20(3):158–173. doi:10.1038/s41568-019-0230-9
6. Puente XS, Jares P, Campo E. Chronic lymphocytic leukemia and mantle cell lymphoma: crossroads of genetic and microenvironment interactions. Blood. 2018;131(21):2283–2296. doi:10.1182/blood-2017-10-764373
7. Das S, Baruah PK, Khakhlari S, Boro G. A clinicopathological study of acute and chronic leukemia in a tertiary care hospital. Indian J Appl Res. 2021;11(8):72–74. doi:10.36106/ijar/7402428
8. Gupta A, Pal A, Nelson SS. Immunophenotyping in acute leukemia: a clinical study. Int J Res Med Sci. 2015;3(4):919–923.
9. Singh G, Parmar P, Kataria S, Singh S, Sen R. Spectrum of acute and chronic leukemia at a tertiary care hospital, Haryana, India. Int J Res Med Sci. 2016;4(4):1115–1118. doi:10.18203/2320-6012.ijrms20160792
10. Yeh C, Moles R, Nicot C. Clinical significance of microRNAs in chronic and acute human leukemia. Mol Cancer. 2016;15(1):37. doi:10.1186/s12943-016-0518-2
11. Thakur A, Kaushik R, Gulati A. Study of patterns of leukaemia in a tertiary care hospital. Int J Res Rev. 2024;11(4):28–40. doi:10.52403/ijrr.20240404
12. Ning L, Hu C, Lu P, et al. Trends in disease burden of chronic myeloid leukemia at the global, regional, and national levels: a population-based epidemiologic study. Exp Hematol Oncol. 2020;9(1):1–13. doi:10.1186/s40164-020-00185-z
13. Aggarwal R, Manuja A, Singh GP. Pattern of cancer in a tertiary care hospital in Malwa region of Punjab, in comparison to other regions in India. J Clin Diagn Res. 2015;9(6):XC05–XC08. doi:10.7860/JCDR/2015/11171.5685
14. Saikia BJ, Roy PS, Kumar G, Mishra RK, Sarma A. Clinico-epidemiological features and response in childhood acute lymphoblastic leukemia at regional cancer center of Northeast India. South Asian J Cancer. 2019;8(4):241–243. doi:10.4103/sajc.sajc_249_19
15. Kumar S, Mahto N, Bharti A, Meena LP. Hematological malignancies in relation with ABO blood group at a teaching hospital, Varanasi, India. J Family Med Prim Care. 2020;9(5):2309–2314. doi:10.4103/jfmpc.jfmpc_1245_19
16. Amare PSK, Jain H, Kabre S, et al. Cytogenetic profile in 7209 Indian patients with de novo acute leukemia: a single centre study from India. J Cancer Ther. 2016;7(7):530–544. doi:10.4236/jct.2016.77056
17. Linet MS, Brown LM, Mbulaiteye SM, et al. International long-term trends and recent patterns in the incidence of leukemias and lymphomas among children and adolescents ages 0–19 years. Int J Cancer. 2016;138(8):1862–1874. doi:10.1002/ijc.29924
18. D'Costa G, Siddiqui HM, Pradhan RM, Gupte SS. Pattern of leukemias: a ten-year incidence study of 242 cases. J Postgrad Med. 1989;35(4):191–195.
19. Kulshrestha R, Sah SP. Pattern of occurrence of leukemia at a teaching hospital in eastern region of Nepal: a six year study. JNMA J Nepal Med Assoc. 2009;48(173):35–40.
20. Modak H, Kulkarni SS, Kadakol GS, et al. Prevalence and risk of leukemia in the multi-ethnic population of North Karnataka. Asian Pac J Cancer Prev. 2011;12(3):671–675.
21. Rego MF, Pinheiro GS, Metze K, Lorand-Metze I. Acute leukemias in Piauí: comparison with features observed in other regions of Brazil. Braz J Med Biol Res. 2003;36(3):331–337. doi:10.1590/s0100-879x2003000300007
22. Chen BA, Huang ZH, Zhang XP, et al. An epidemiological investigation of leukemia incidence between 2003 and 2007 in Nanjing, China. J Hematol Oncol. 2010;3:21. doi:10.1186/1756-8722-3-21
23. Harani MS, Adil SN, Shaikh MU, et al. Frequency of FAB subtypes in acute myeloid leukemia patients at Aga Khan University Hospital Karachi. J Ayub Med Coll Abbottabad. 2005;17(1):26–29.
24. Ullah K, Ahmed P, Raza S, et al. Management of acute myeloid leukaemia: 5 years experience at Armed Forces Bone Marrow Transplant Centre, Rawalpindi. J Pak Med Assoc. 2007;57(9):434–439.
25. Salkar AB, Patrikar A, Bothale K, et al. Clinicohematological evaluation of leukemias in a tertiary care hospital. IOSR J Dent Med Sci. 2014;13:126–134.
26. Gupta N, Pawar R, Banerjee S, et al. Spectrum and immunophenotypic profile of acute leukemia: a tertiary center flow cytometry experience. Mediterr J Hematol Infect Dis. 2019;11(1):e2019017. doi:10.4084/MJHID.2019.017.

ISSN (O): 2687-5365; ISSN (P): 2753-6556