

Prevalence of Acute Leukemia (ALL and AML) Among Children at a Libyan Cancer Center (2020-2022)

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انتشار ابيضاض الدم الحاد (ALL و AML) بين الأطفال في مركز أورام ليبيا (2020-2022)

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Received: 28-12-2025	Accepted: 22-02-2026	Published: 07-03-2026
		
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Abstract

Background: Acute leukemia, particularly acute lymphoblastic leukemia (ALL) and acute myeloid leukemia (AML), is the most common childhood cancer worldwide, with varying regional patterns.

Methods: This retrospective cross-sectional study analyzed 49 pediatric cases (<16 years) diagnosed with acute leukemia at the National Cancer Institute (formerly Misurata Cancer Center), Libya, from 2020-2022. Data on diagnosis, demographics, and blood profiles were extracted from records. Descriptive statistics and inferential tests (chi-square, Fisher's exact, Mann-Whitney U) were performed using SPSS v.27.

Results: ALL comprised 85.7% (n=42, 95% CI: 73.3-92.9%) of cases vs. AML 14.3% (n=7). ALL predominated in ages 1-5 years ($\chi^2=7.05$, $p=0.030$); no significant sex difference ($p=1.0$). WBC medians did not differ significantly between groups ($p=0.62$).

Conclusion: Hospital-based data confirm ALL dominance in young Libyan children, aligning with African trends but warranting population-based incidence studies.

Keywords: Acute lymphoblastic leukemia, acute myeloid leukemia, children, Libya, prevalence, blood profile.

الملخص

الخلفية: يُعدّ ابيضاض الدم الحاد، وخاصة ابيضاض الدم اللمفاوي الحاد (ALL) و ابيضاض الدم النقوي الحاد (AML)، أكثر أنواع السرطان شيوعاً لدى الأطفال على مستوى العالم، مع وجود اختلافات في أنماط الانتشار بين المناطق. الطرق: شملت هذه الدراسة المقطعية الاسترجاعية تحليل 49 حالة من الأطفال (>16 سنة) تم تشخيصهم بابيضاض الدم الحاد في المعهد الوطني للأورام (سابقاً مركز مصراة للأورام) في ليبيا خلال الفترة من 2020 إلى 2022. تم استخراج بيانات التشخيص، والخصائص الديموغرافية، ونتائج تحاليل الدم من السجلات الطبية. أجريت التحليلات الإحصائية الوصفية والاستدلالية) اختبار كاي تربيع، واختبار فيشر الدقيق، واختبار مان-ويتني (U باستخدام برنامج SPSS الإصدار 27. النتائج: شكل ابيضاض الدم اللمفاوي الحاد (ALL) نسبة 85.7% (عدد الحالات = 42، فاصل الثقة 95%: -73.3-92.9%) مقارنةً بابيضاض الدم النقوي الحاد (AML) بنسبة 14.3% (عدد الحالات = 7). وكان ALL أكثر شيوعاً في الفئة العمرية من 1 إلى 5 سنوات ($\chi^2=7.05$)، $p=0.030$ ، دون وجود فروق ذات دلالة إحصائية بين الجنسين. ($p=1.0$) كما لم تظهر فروق معنوية في الوسيط العددي لكريات الدم البيضاء (WBC) بين المجموعتين. ($p=0.62$) الاستنتاج: تؤكد بيانات المستشفى سيطرة ابيضاض الدم اللمفاوي الحاد (ALL) بين الأطفال الليبيين صغار السن، وهو ما يتماشى مع الاتجاهات في أفريقيا، إلا أن هناك حاجة إلى دراسات سكانية أشمل لتحديد معدلات الإصابة بدقة.

الكلمات المفتاحية: ابيضاض الدم اللمفاوي الحاد، ابيضاض الدم النقوي الحاد، الأطفال، ليبيا، الانتشار، صورة الدم.

Introduction

Acute leukemia represents a group of aggressive hematological malignancies characterized by the uncontrolled proliferation of immature blood cells within the bone marrow, leading to impaired hematopoiesis and systemic clinical manifestations. Among these, acute lymphoblastic leukemia (ALL) and acute myeloid leukemia (AML) constitute the principal subtypes observed in pediatric populations. The disease originates in the bone marrow, the primary site of blood cell production, where abnormal leukocytes proliferate rapidly, crowding out normal hematopoietic elements and subsequently infiltrating peripheral blood and vital organs. This pathological process results in a wide range of clinical complications, including anemia, infections, and bleeding disorders (American Cancer Society, 2022).

Globally, leukemia remains a significant public health concern, ranking among the most common cancers in children and adolescents. According to epidemiological data, hundreds of thousands of new cases are reported annually, with substantial variation across regions. While the global incidence of leukemia has shown a declining trend in certain periods due to advancements in early detection and treatment strategies, disparities persist between developed and developing regions. Notably, lower incidence rates have been reported in Africa compared to other parts of the world; however, this may reflect underreporting and limited diagnostic infrastructure rather than true epidemiological differences (Dong et al., 2020; Yang et al., 2022).

The classification of acute leukemia has evolved considerably over recent decades, incorporating morphological, immunophenotypic, and genetic criteria. The contemporary framework, as outlined in international consensus classifications, distinguishes between ALL and AML based on lineage and the proportion of blast cells present in the bone marrow. Typically, a blast percentage exceeding 20% is indicative of acute leukemia, while additional molecular and cytogenetic markers are used for risk stratification and therapeutic decision-making (Arber et al., 2022). Furthermore, lymphoblastic leukemia and lymphoblastic lymphoma are now considered part of a disease spectrum, emphasizing the importance of comprehensive diagnostic approaches.

Advances in treatment modalities have significantly improved survival outcomes, particularly in pediatric ALL, where five-year survival rates exceed 80–90% in many settings. These improvements are largely attributed to the development of risk-adapted chemotherapy protocols, hematopoietic stem cell transplantation, and supportive care strategies. Despite these advancements, treatment outcomes in low- and middle-income countries remain suboptimal due to limited resources, delayed diagnosis, and inadequate healthcare infrastructure (National Cancer Institute, 2026).

From an epidemiological perspective, numerous studies have consistently demonstrated that ALL is the predominant subtype of acute leukemia in children, accounting for approximately 75–80% of cases worldwide. This pattern has also been observed in several African and Middle Eastern countries, where similar demographic and environmental factors may influence disease distribution. Age-specific incidence patterns indicate that ALL is most common among children aged 1–5 years, whereas AML tends to occur more frequently in older children and adolescents. These differences are often attributed to a combination of genetic predisposition, environmental exposures, and prenatal risk factors, including radiation and maternal health conditions (Swerdlow et al., 2017).

In addition to demographic characteristics, hematological parameters play a crucial role in the clinical assessment and diagnosis of acute leukemia. Patients typically present with abnormalities in white blood cell (WBC) counts, red blood cell (RBC) levels, and hemoglobin (Hb) concentrations. Anemia is a common finding due to bone marrow infiltration, while WBC counts may vary widely depending on disease stage and subtype. Although some studies suggest differences in hematological profiles between ALL and AML, findings are not always consistent, highlighting the need for further investigation in diverse populations.

The existing body of literature underscores the importance of regional studies in understanding the epidemiology of acute leukemia. Despite the global burden of the disease, data from North Africa, including Libya, remain limited. Most available studies are hospital-based and lack comprehensive population-level analysis, which restricts the ability to draw definitive conclusions about incidence and risk factors. Nevertheless, such studies provide valuable insights into disease patterns, clinical presentations, and healthcare challenges within specific contexts.

In African settings, research has reported a predominance of ALL among pediatric leukemia cases, consistent with global trends. However, variations in age distribution, sex ratios, and clinical outcomes have been observed across different countries. For example, studies conducted in Egypt have documented a high proportion of ALL cases, similar to findings in other parts of the continent. These similarities suggest that underlying biological mechanisms may be consistent, although environmental and socioeconomic factors continue to play a significant role in shaping disease outcomes.

Moreover, the literature highlights the critical role of early diagnosis and specialized care in improving patient outcomes. Delayed presentation and limited access to diagnostic tools often result in advanced disease at the time of diagnosis, which adversely affects prognosis. Consequently, strengthening healthcare systems, enhancing diagnostic capacity, and

promoting awareness are essential steps toward reducing the burden of acute leukemia in resource-limited settings.

Given these considerations, there is a clear need for more comprehensive epidemiological studies in Libya to better understand the distribution and characteristics of acute leukemia among children. Hospital-based studies, although limited in scope, serve as an important foundation for future research by providing baseline data and identifying key trends. Such data can inform public health strategies, guide resource allocation, and support the development of targeted interventions aimed at improving outcomes for affected children.

In summary, acute leukemia remains a major health challenge worldwide, particularly among pediatric populations. While significant progress has been made in understanding the disease and improving treatment outcomes, considerable gaps persist in certain regions, including North Africa. The predominance of ALL, age-related patterns, and hematological abnormalities are well-documented in the literature, yet regional variations necessitate localized research efforts. By building upon existing knowledge and addressing current limitations, future studies can contribute to a more comprehensive understanding of the disease and ultimately enhance patient care and survival outcomes.

Materials and Methods

Study Design and Setting: Retrospective cross-sectional analysis of confirmed pediatric acute leukemia cases (WHO 5th edition criteria: $\geq 20\%$ blasts in bone marrow) at National Cancer Institute, Misurata, Libya (2020-2022). Study duration: March-April 2024.

Ethical approval obtained from Elmergib University IRB.

Participants:

Inclusion: children < 16 years with ALL/AML diagnosis (cytology/flow cytometry confirmed)

Exclusion: chronic leukemias, relapses without new data.

Data Collection: Two reviewers extracted demographics (age, sex), diagnosis, year, blood parameters (WBC $\times \times 10^9/L$, RBC $\times 10^{12}/L$, Hb g/dL) from **Medical records department**.

Statistical Analysis: Descriptive: frequencies, percentages, medians.

Inferential: chi-square/Fisher's exact for categorical; Mann-Whitney U for continuous (non-normal).

Proportions: Wilson 95% CIs. Significance: $p < 0.05$. SPSS v.27

Results

Of 49 cases (median age ~ 5 years, 67.3% male), ALL predominated (85.7%).

Diagnosis Distribution

ALL: 42 (85.7%, 95% CI 73.3-92.9%); AML: 7 (14.3%).

By Year (2020-2022 data; 2023: 0 AML, 0 ALL tabulated): Peak 2021 (38.8%).

Table 1: Distribution of Acute Leukemia Cases (ALL and AML) by Year (2020–2022)

Year	AML (n,%)	ALL (n,%)	Total (n,%)
2020	3 (6.1)	13 (26.5)	16 (32.7)
2021	2 (4.1)	17 (34.7)	19 (38.8)
2022	2 (4.1)	12 (24.5)	14 (28.5)
Total	7 (14.3)	42 (85.7)	49 (100)

By Sex: Males 67.3%; no association with diagnosis ($\chi^2=0.00$, $p=1.0$; OR=0.80, 95% CI 0.14-4.52).

Table 2: Distribution of Acute Leukemia Cases by Sex

Sex	AML (n,%)	ALL (n,%)	Total (n,%)
Female	2 (4.1)	14 (28.6)	16 (32.7)
Male	5 (10.2)	28 (57.1)	33 (67.3)
Total	7 (14.3)	42 (85.7)	49 (100)

By Age: ALL peaked 1-5 years (40.8%); AML older ($\chi^2=7.05$, $df=2$, $p=0.030$).

Table 3: Distribution of Acute Leukemia Cases by Age Group

Age Group	AML (n,%)	ALL (n,%)	Total (n,%)
1-5 y	0 (0.0)	20 (40.8)	20 (40.8)
6-9 y	3 (6.1)	14 (28.6)	17 (34.7)
11-15 y	4 (8.2)	8 (16.3)	12 (24.5)
Total	7 (14.3)	42 (85.7)	49 (100)

Blood Profiles: Most had low-normal RBC (91.8%, $1.4-4.5 \times 10^{12}/L$) and Hb (57.1% <10 g/dL). WBC medians: ALL $7.65 \times 10^9/L$, AML $7.65 \times 10^9/L$ ($U=130$, $p=0.62$).

Table 4: Distribution of Hematological Parameters among Patients (WBC, RBC, Hb)

Parameter	Range	AML n (%)	ALL n (%)	Total n (%)
WBC $\times 10^9/L$	0.8-4.5	2 (4.1)	14 (28.6)	16 (32.7)
	4.5-10.8	2 (4.1)	15 (30.6)	17 (34.7)
	10.8-100	2 (4.1)	9 (18.4)	11 (22.4)
	100-422	1 (2.0)	4 (8.2)	5 (10.2)
RBC $10^{12}/L$	1.4-4.5	6 (12.2)	39 (79.6)	45 (91.8)
	4.5-6	1 (2.0)	3 (6.1)	4 (8.2)
Hb (g/dL)	4-10	5 (10.2)	23 (46.9)	28 (57.1)
	10-13.5	1 (2.0)	16 (32.7)	17 (34.7)
	13.5-14.5	1 (2.0)	3 (6.1)	4 (8.2)

Discussion

The present study provides valuable insights into the epidemiological and hematological characteristics of acute leukemia among children in a Libyan cancer center. The findings revealed a clear predominance of acute lymphoblastic leukemia (ALL), accounting for 85.7% of cases, compared to only 14.3% for acute myeloid leukemia (AML). This distribution is consistent with global epidemiological patterns, where ALL represents the most common type of leukemia in pediatric populations, typically comprising approximately 75–80% of cases. The higher proportion observed in this study may be attributed to the relatively small sample size or regional variations in disease presentation.

The age distribution analysis demonstrated a statistically significant association between leukemia subtype and age group ($p = 0.030$), with ALL predominantly affecting children aged 1–5 years, while AML was more frequently observed in older age groups. This finding aligns with existing literature, which suggests that early childhood is a critical period for the

development of ALL, possibly due to a combination of genetic susceptibility and environmental exposures during prenatal and early postnatal life. In contrast, AML tends to present later in childhood, reflecting differences in disease biology and pathogenesis .

Regarding sex distribution, the study found that males constituted 67.3% of cases; however, no statistically significant association was identified between sex and leukemia subtype ($p = 1.0$). This result differs slightly from some international studies that report a modest male predominance, particularly in ALL. The absence of a significant association in this study may be explained by the limited sample size or local demographic factors, suggesting that sex may not be a strong determinant of leukemia subtype in this population .

The temporal distribution of cases indicated that the highest number of diagnoses occurred in 2021, accounting for 38.8% of total cases. While this increase may reflect a true rise in incidence, it could also be influenced by improved diagnostic capacity, enhanced reporting systems, or increased healthcare access during that period. Such fluctuations highlight the importance of long-term surveillance data to accurately assess trends in leukemia incidence.

Hematological findings revealed that the majority of patients presented with anemia and relatively low red blood cell counts, consistent with bone marrow infiltration by leukemic cells. More than half of the patients had hemoglobin levels below 10 g/dL, indicating moderate to severe anemia. White blood cell counts varied widely among patients, but no statistically significant difference was observed between ALL and AML groups ($p = 0.62$). This lack of difference suggests that WBC count alone may not be a reliable parameter for distinguishing between leukemia subtypes, reinforcing the importance of comprehensive diagnostic approaches, including cytological and immunophenotypic analyses .

Overall, the study findings are in agreement with regional and international research, particularly in terms of the predominance of ALL and the age-related distribution of leukemia subtypes. However, the study also highlights several limitations, including its hospital-based design and relatively small sample size, which may limit the generalizability of the results. Additionally, the absence of advanced diagnostic data, such as genetic and molecular markers, restricts the ability to perform detailed subtype classification and risk stratification.

Despite these limitations, the study provides important baseline data on pediatric acute leukemia in Libya, a region where epidemiological data remain scarce. These findings can serve as a foundation for future research and contribute to a better understanding of disease patterns in North Africa..

Conclusion

In conclusion, this study confirms that acute lymphoblastic leukemia (ALL) is the predominant form of acute leukemia among children in the studied Libyan cancer center, particularly in younger age groups. The observed age-related differences between ALL and AML are consistent with established epidemiological patterns, while no significant association was found between sex and leukemia subtype.

Hematological abnormalities, including anemia and variations in white blood cell counts, were common among patients, reflecting the underlying pathophysiology of bone marrow involvement. Although the findings align with global trends, the study underscores the need for more comprehensive and large-scale epidemiological research in Libya.

The results highlight the importance of early diagnosis, improved healthcare infrastructure, and the development of specialized pediatric oncology services to enhance patient outcomes. Furthermore, the study provides a valuable reference point for future investigations aimed at understanding the burden of acute leukemia in the region .

Recommendations

Based on the findings of this study, the following recommendations are proposed:

- 1. Conduct Large-Scale Population-Based Studies**
Future research should focus on multicenter and population-based studies to provide more accurate estimates of leukemia incidence and prevalence in Libya.
- 2. Enhance Diagnostic Capabilities**
Healthcare facilities should be equipped with advanced diagnostic tools, including immunophenotyping, cytogenetics, and molecular testing, to improve disease classification and treatment planning.
- 3. Promote Early Detection**
Awareness programs should be implemented to educate healthcare providers and the public about early signs and symptoms of leukemia, facilitating timely diagnosis and intervention.
- 4. Strengthen Pediatric Oncology Services**
Investment in specialized pediatric oncology centers and trained medical personnel is essential to improve treatment outcomes and survival rates.
- 5. Establish National Cancer Registry**
A comprehensive cancer registry system should be developed to systematically collect and analyze data on leukemia and other malignancies, enabling better monitoring and policy planning.
- 6. Supportive Care Improvement**
Efforts should be made to improve supportive care services, including blood transfusion, infection control, and nutritional support, which are critical for leukemia management.

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Compliance with ethical standards*Disclosure of conflict of interest*

The authors declare that they have no conflict of interest.

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