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# Incidence, patterns of clinical presentation, and haematological characteristics of paediatric acute myeloid leukaemia in Uganda: a retrospective analysis

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## Abstract

**Background** Current understanding of paediatric acute myeloid leukaemia (AML) in Africa is limited. This study investigated the incidence, presentation pattern, and haematological profiles of paediatric AML in Uganda.

**Methods** This retrospective cohort study examined the medical records of children under 18 years of age who were diagnosed with acute myeloid leukaemia (AML) at three cancer centres in Uganda from 2016 to 2022. Data included demographics, clinical features, and laboratory findings. Frequencies, bivariate analyses, and regression models were performed, with statistical significance set at  $p < 0.05$ .

**Results** The study included 159 children diagnosed with AML, with a median age of 9.0 years (IQR 3.0–12.0). The incidence was 7.0/million children 0–17 years. The most common presenting symptoms were fever (84.3%), weight loss (44.0%), fatigue (40.9%), bleeding (35.8%), and bone pain (28.9%). Clinical findings at diagnosis included splenomegaly (40.9%), lymphadenopathy (39.6%), myeloid sarcoma (39.6%), and hepatomegaly (37.7%). The median (IQR) white blood cell (WBC) count at diagnosis was  $32.0 \times 10^9/L$  (0.3–81.8). The predominant FAB subtype was M7 ( $n = 22$ , 24.4%), followed by M5 ( $n = 20$ , 22.2%). Acute promyelocytic leukaemia was seen in 13 (8.2%) patients, while 11 (6.9%) patients had myeloid leukaemia of Down syndrome. Cytogenetic analysis was limited to only 10 patients. There were significant differences in clinical characteristics by age with respect to splenomegaly, central nervous system involvement, and FAB subtype.

**Conclusions** The incidence of paediatric AML in this study mirrors global patterns, with a higher-than-expected prevalence of the M7 subtype noted. In settings with limited resources, diagnosis relies mainly on clinical and morphological assessment. Broader access to cytogenetic and molecular testing could improve subtype identification and risk profiling.

**Keywords** Acute myeloid leukaemia, Paediatric, Incidence, Epidemiology, Uganda, Africa

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## Introduction

Paediatric acute myeloid leukaemia (AML) accounts for approximately 20–25% of acute leukaemia globally [1, 2], with an estimated 15,000 to 20,000 new cases annually [3]. The incidence of paediatric AML varies by geographic region and age, with ethnicity postulated as one of several contributing factors [4, 5], which partly include socioeconomic and biologic factors [6]. Studies report an initial incidence peak before one year of age, followed by a second peak between 15 and 20 years, with a mean age at diagnosis of around five years [7].

In low- and middle-income countries (LMICs), the true incidence and epidemiological patterns of paediatric AML remain largely unknown, primarily due to the fact that many children remain undiagnosed, in addition to underreporting, the absence of comprehensive cancer registries, limited availability of literature, and frequent misdiagnosis [2, 8]. Earlier reports from Nigeria suggested that up to 50%–57.5% of all acute leukaemia was AML [9, 10], though more recent reports from African hospital cancer registries suggest that 20–25% of acute leukaemia is AML, aligning with global experiences [2, 11]. A report from a population-based study in 17 LMICs showed that the proportion of paediatric AML in African and Asian LMICs was similar to, or slightly higher than, the proportion in HICs [12].

In Uganda, the true burden of childhood AML remains underreported, and the incidence and epidemiological characteristics are not clearly established. The absence of a national paediatric cancer registry, standardised AML reporting algorithms, and electronic data management systems hinders the collection of accurate population-based data. An earlier report from the national cancer treatment centre indicated that up to 33% of paediatric acute leukaemia were AML, excluding acute promyelocytic leukaemia (APL) [13]. This aligns with anecdotal observations suggesting a higher proportion of AML cases than reported in the literature. However, as in many limited-resource settings, paediatric AML remains poorly defined in Uganda.

Although AML diagnosis conventionally depends on cytogenetic, immunophenotypic, and cytochemical analyses, these diagnostic tools are often unavailable in Uganda and similar resource-limited settings. Consequently, diagnosis in these environments relies predominantly on clinical assessment and bone marrow morphology, with classification based on the FAB criteria [14]. A comprehensive characterisation of the clinico-haematological features is thus essential [15]. Familiarity with the clinical and laboratory profiles of paediatric AML among haematologist-oncologists and frontline clinicians is imperative to facilitate prompt recognition and referral – addressing the challenges of delayed diagnosis, misdiagnosis, and missed diagnosis by

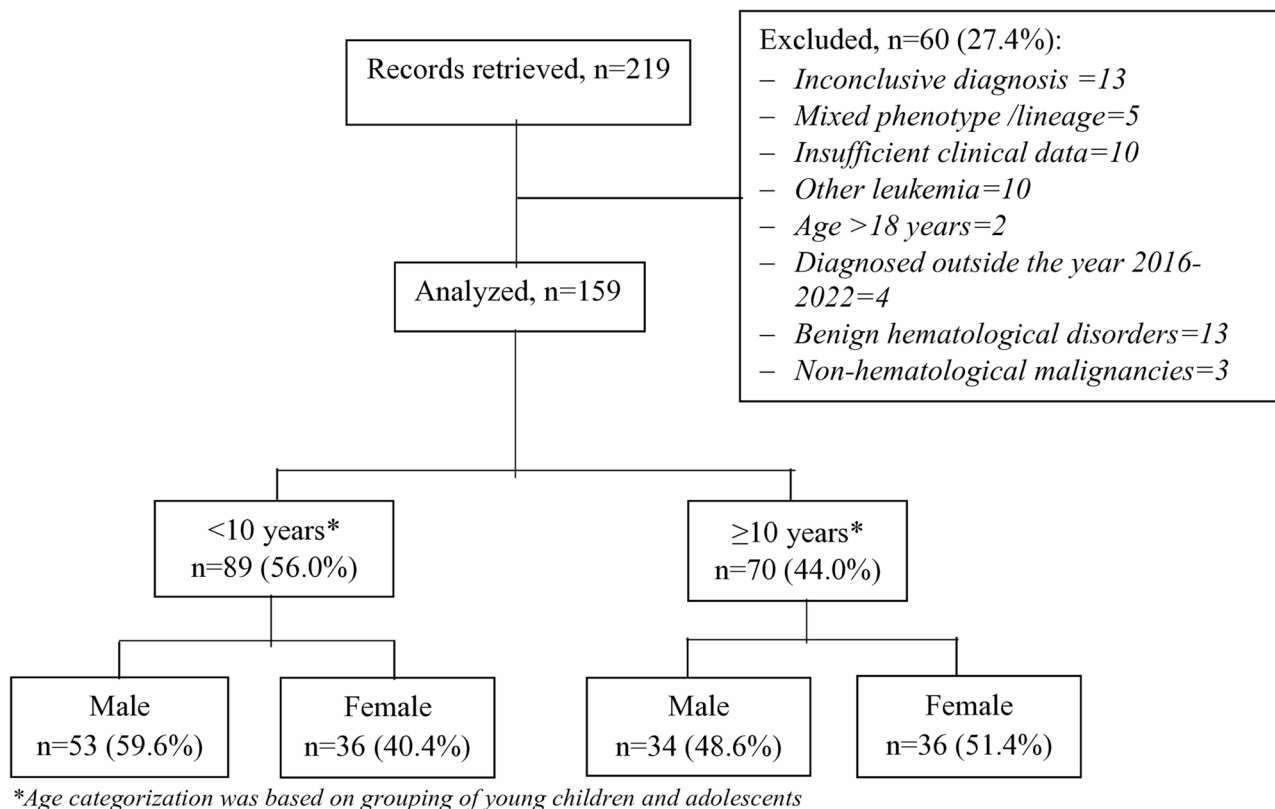
primary healthcare providers – which partly contributes to poor outcomes in LMICs [16, 17].

## Methods

This retrospective cohort study reviewed the medical records of children diagnosed with AML at three cancer treatment centres in Uganda between January 2016 and December 2022. These included the national referral cancer centre and two additional facilities. Collectively, the three centres manage approximately 700 new childhood cancer diagnoses per year.

All children and adolescents under 18 years diagnosed with AML within the period under consideration were included. Patients were excluded if they had an inconclusive diagnosis, mixed phenotype or mixed lineage leukaemia, and incomplete medical records lacking essential clinical details (see Fig. 1). Data for this study were accessed and collected between November 01, 2024, and June 31, 2025. The data collection included socio-demographic variables (age, sex, and home region) and disease characteristics, such as symptom duration, clinical presentation, baseline laboratory indices, and the French-American-British (FAB) classification.

The diagnosis of AML was confirmed based on bone marrow and/or peripheral blood smear morphology, with subtyping according to the FAB classification [18]. Flow cytometry was performed in a limited number of patients due to limited and inconsistent availability of the services at the national central public health laboratory, while cytogenetic and molecular testing were conducted externally in South Africa for a few patients due to the lack of in-country capacity. Central nervous system (CNS) status was assessed via cerebrospinal fluid (CSF) analysis. CNS involvement was defined by the presence of  $>5$  WBCs/mm<sup>3</sup> of the CSF, with blasts present in a non-bloody tap [19] and/or the presence of clinical CNS symptoms—including facial nerve palsy. Additional investigations, including imaging, were performed as clinically indicated. Nutritional status was assessed using the World Health Organization weight-for-height, body mass index (BMI)-for-age, and mid-upper-arm circumference (MUAC) z-scores [20]. Nutritional status was classified as normal (z-score  $>-2$  SD), moderately malnourished (z-score  $<-2$  and  $>-3$ SD), or severely malnourished (z-score  $<-3$  SD) [20]. Myeloid sarcoma (MS) was diagnosed clinically without histopathological confirmation, based on the following criteria: (i) an established diagnosis of AML at the time the lesion was identified, (ii) typical imaging features in some cases, showing a homogeneous soft tissue mass consistent with previously described characteristics of myeloid sarcoma [21–24], (iii) lesion localisation at anatomical sites commonly



**Fig. 1** Flow diagram

involved in myeloid sarcoma (e.g., orbit, skin, and soft tissues), and (iv) the absence of other plausible differential diagnoses.

Incidence of paediatric AML was estimated as the number of cases per one million children aged 0–17 years, based on population estimates from the 2024 National Population and Housing Census [25]. According to the census report, approximately half (22,750,701) of Uganda's total population of 45.9 million were children and adolescents aged 0–17 years, with 13,321,659 children younger than 10 years and 9,429,042 individuals aged 10–17 years [25].

Data were analysed using the Statistical Package for Social Sciences (SPSS) software package (SPSS for Windows, Version 27.0. Chicago, SPSS Inc.). Descriptive statistics were summarised as proportions for categorical variables, while continuous variables were summarised as means (standard deviation) if normally distributed or medians (interquartile range) if non-normally distributed. The chi-square test was used to assess the variability between categorical variables, and multivariate logistic regression was performed to examine the relationship between FAB classification and selected variables. A two-sided p-value of  $< 0.05$  was considered for statistical significance. For comparison, we categorised age into  $< 10$  years and  $\geq 10$  years [26], while WBC was

categorised as  $< 50,000/L$  and  $\geq 50,000/L$  [26], and LDH as  $< 500 U/L$  and  $\geq 500 U/L$  [27].

## Results

There were 219 records retrieved from the three Ugandan centres, 159 of which had children diagnosed with acute myeloid leukaemia who met the eligibility criteria who were included for data analysis (Fig. 1).

The median age at diagnosis was 9.0 years (interquartile range: 3.0–12.0 years; age range: 11 months to 17 years). More than half of the children ( $n=89$ , 56.0%) were younger than 10 years. Over half were males ( $n=87$ ; 54.7%), with a male-to-female ratio of 1.2:1. Regionally, the central region accounted for the highest proportion of cases, with 67 (42.1%), while the northern region had the lowest, at 23 (14.5%) (Table 1).

The median duration from onset to presentation was 60 days (interquartile range [IQR]: 21–90 days) – being shorter among children younger than two years. Fever was the most reported symptom ( $n=134$ , 84.3%), followed by weight loss ( $n=70$ , 44.0%), fatigue ( $n=65$ , 40.9%), and bleeding ( $n=57$ , 35.8%). Bleeding manifestations were primarily nasal ( $n=26$ ) and oral/gum ( $n=29$ ) (Supplementary Table 1).

The most frequently observed clinical features at diagnosis were splenomegaly ( $n=65$ , 40.9%), peripheral

**Table 1** Socio-demographic characteristics of children with AML in Uganda

Variable	n	%
Age (years)		
Median (IQR)	9.0	3.0-12.0
<1	9	5.7
1–9.9	80	50.3
≥10	70	44
Sex		
Male	87	54.7
Female	72	45.3
Regional location		
Central	67	42.1
Eastern	30	18.9
Western	39	24.5
Northern	23	14.5
Source of referral		
Primary-level facility	13	8.2
Secondary-level facility	33	20.8
Tertiary-level facility	67	42.1
Unknown/self-referral	46	28.9

IQR Interquartile range

**Table 2** Clinical characteristics of paediatric AML patients and AML subtypes

Variable	Frequency	%
Physical features		
Splenomegaly	65	40.9
Peripheral lymphadenopathy	63	39.6
Hepatomegaly	60	37.7
Proptosis (orbital MS)	35	22.0
Non-orbital MS	28	17.6
Bleeding	22	13.8
Abdominal lymphadenopathy	16	10.1
Gum hyperplasia	11	6.9
Nutritional status¶		
Normal	97	61.0
Moderate acute malnutrition	30	18.9
Severe acute malnutrition	32	20.1
CNS involvement (n=96)		
Yes	14	14.6
No	82	85.4
AML subtypes		
Non-APL AML	132	83.0
APL	13	8.2
ML-DS	11	6.9
Treatment-related	2	1.3
MDS-related	1	0.6

CNS Central nervous system, ¶ according to World Health Organization (WHO) classification, APL Acute promyelocytic leukaemia, ML-DS Myeloid leukaemia of Down syndrome, MDS Myelodysplastic syndrome

lymphadenopathy ( $n=63$ , 39.6%), and hepatomegaly ( $n=60$ , 37.7%). MS was another frequent clinical finding, occurring as orbital MS (proptosis) in 35 patients (22.0%) and as non-orbital MS in 28 patients (17.6%).

Approximately two in five children ( $n=62$ ; 39.0%) were malnourished. There were 96 patients (60.4%) evaluated for CNS disease, of whom 14 (14.6%) had CNS involvement, five of whom also had clinical CNS symptoms (Table 2).

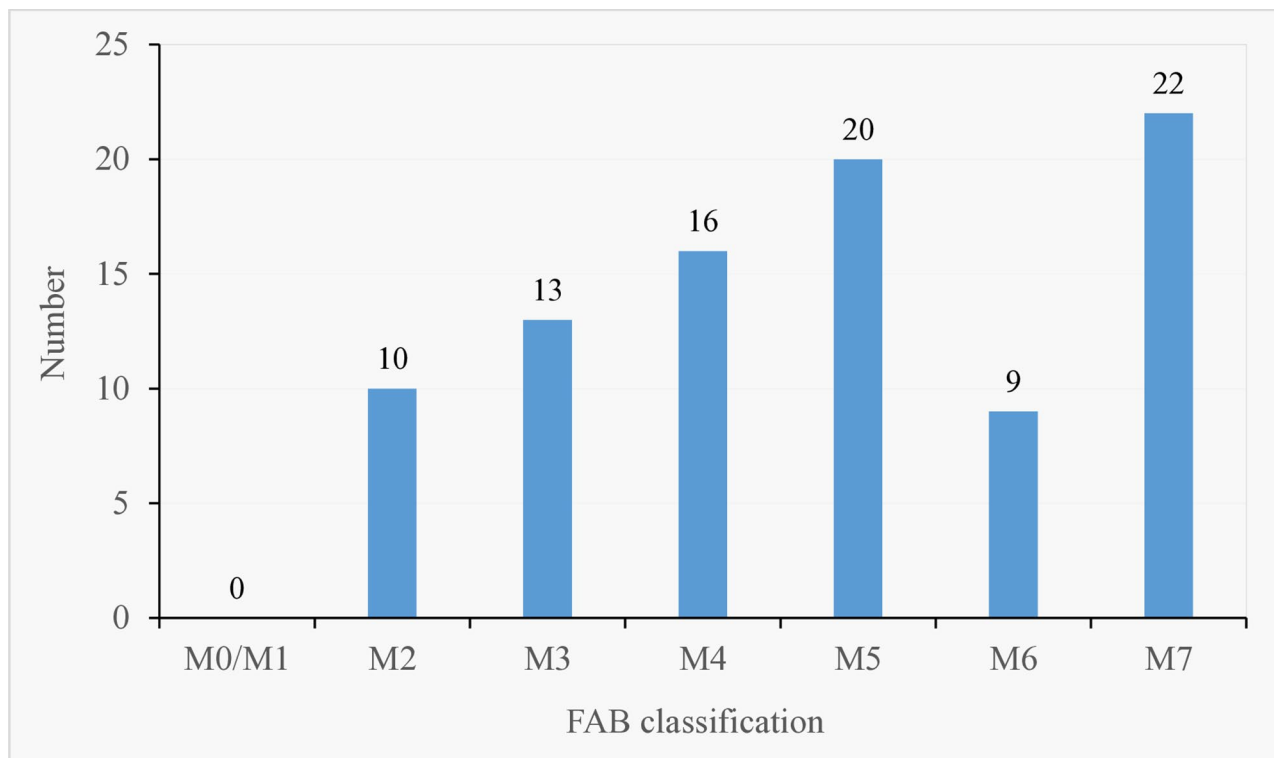
Hepatosplenomegaly was most common in patients with AML-M5, M7, and M4 subtypes. Lymphadenopathy was frequently observed in AML-M5 ( $n=14$ ) and AML-M4 ( $n=8$ ). Extramedullary manifestations such as orbital MS (presenting as proptosis) ( $n=9$ ; 5.7%) and non-orbital MS in other sites ( $n=6$ ; 3.8%) were seen in AML-M5. The association between the other clinical features and the FAB subtypes are as shown in Supplementary Table 2. The most common FAB subtype of AML in our study was M7, which was observed in 22 (24.4%) patients. This was followed by the M5 in 20 (22.2%) patients and the M4, which was observed in 16 (17.8%) patients. The other FAB subtypes were as shown in Fig. 2.

The median baseline total white blood cell (WBC) count for the whole cohort of AML patients was  $32.0 \times 10^9/L$  (IQR 10.3–81.6). The median percentage of myeloblasts in peripheral blood and bone marrow smears was 60.0% (IQR: 50.0–85.0%) and 50.0% (IQR: 40.0–70.0%), respectively. Cytogenetic analysis was performed in only 10 (6.3%) patients; of these, six (60.0%) had the t(8;21) translocation. The rest of the laboratory parameters are as summarised in Table 3.

The estimated crude incidence of paediatric AML is 7.0 cases per million children aged 0–17 years, based on the current cohort and population estimates from the 2024 National Population and Housing Census [25]. Age-specific incidence rates were 6.7 per million among children younger than 10 years and 7.4 per million among those aged 10–17 years.

There was an increase in cases for the whole cohort over the seven-year period, with a more gradual increase over time for the younger age groups (<2 years and 2–4.9 years) (Fig. 3A). A sustained upward trend in the number of paediatric AML cases was observed in the central region, with a similar but less marked pattern in the southern/western region (Fig. 3B). Notably, regional age distribution patterns differed: the western region had a higher proportion of older children diagnosed with AML, while the northern region had predominantly younger children (Fig. 3C). Trends over time by sex indicated similar patterns for both males and females, with a slight predominance of males noted after 2018 (Fig. 3D).

We compared the characteristics of the cohort based on their ages, categorised into <10 years and ≥10 years. A higher proportion of older children (≥10 years) was reported in the western region (38.6% vs. 13.5%);  $p<0.001$ , while the northern region had a higher proportion of younger children (<10 years) (20.2% vs. 7.1%;  $p<0.001$ ). Clinical characteristics also differed



**Fig. 2** Paediatric AML FAB subtype classification

**Table 3** Haematological and biochemical parameters of paediatric AML at diagnosis

Variable	Median	IQR
Haematological parameters§		
Total White Blood Cell counts ( $\times 10^9/L$ )	32.0	10.3 – 81.6
Absolute Neutrophil counts ( $\times 10^9/L$ )	3.5	1.4 – 13.0
Monocytes ( $\times 10^9/L$ )	7.0	1.7 – 25.6
Haemoglobin concentration (g/dL)	5.8	4.3 – 7.6
Platelets counts ( $\times 10^9/L$ )	24.5	10.8 – 56.0
Blast percentage		
% Blast in peripheral blood smear	60.0	50.0 – 85.0
% Blast in Bone Marrow smear	50.0	40.0 – 70.0
Biochemical parameters		
Lactate dehydrogenase (U/L)	750.5	444.5 – 1699.3
Serum albumin (g/L)	33.1	30.0 – 38.0
Variable	n	%
Specific cytogenetics (n=10)		
t(8;21)	6	60.0
t(2;7)	1	10.0
Monosomy 7	1	10.0
Normal karyotype	2	20.0

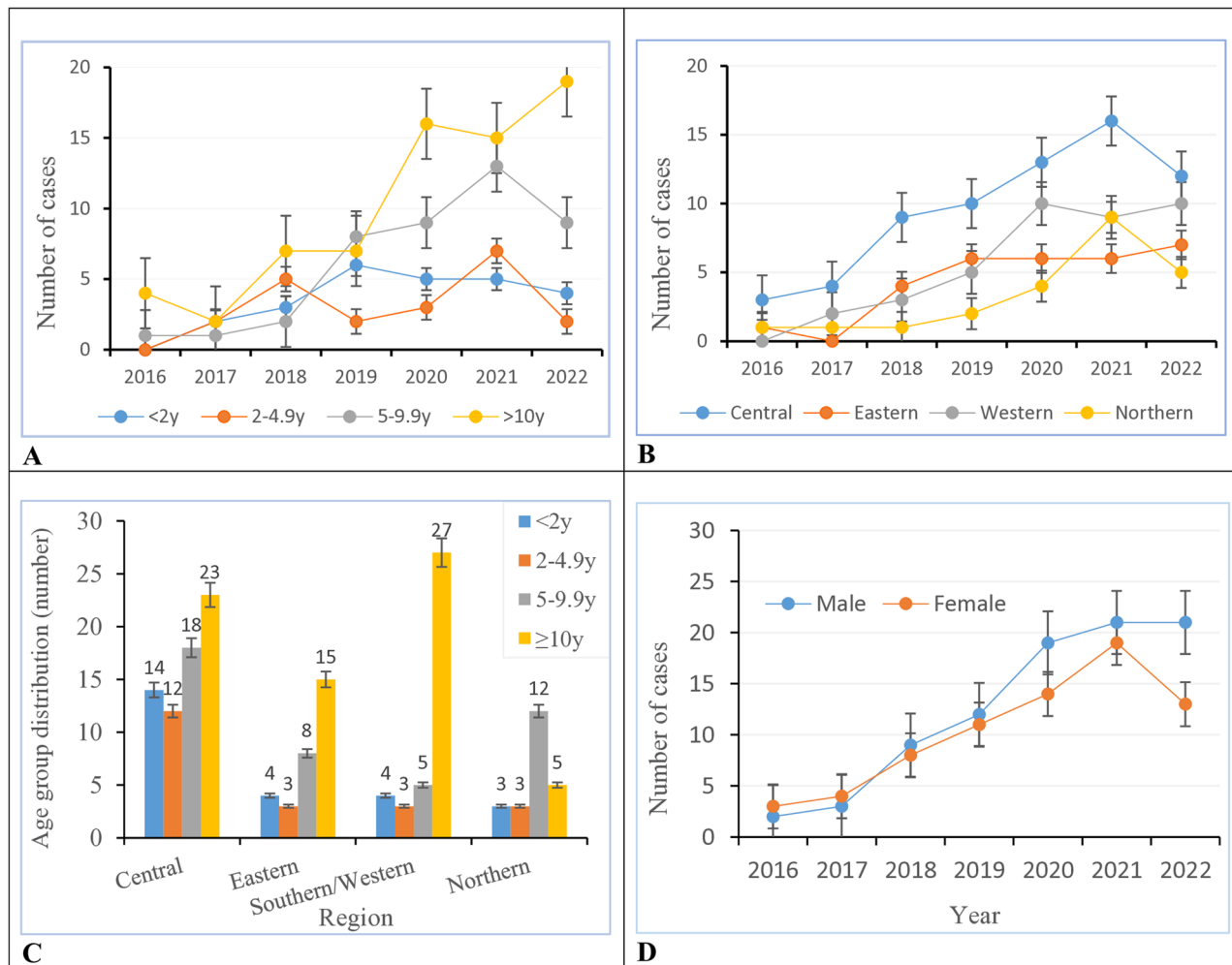
AML Acute myeloid leukaemia, § At diagnosis, IQR Interquartile range

significantly between age groups. Younger children (< 10 years) were more likely to present with splenomegaly (66.2% vs. 33.8%;  $p=0.031$ ), whereas older children ( $\geq 10$  years) had a higher prevalence of CNS involvement (11.4% vs. 6.7%;  $p=0.014$ ). The younger age group had

a markedly lower incidence of the AML-M3 subtype at 2.2% compared to 17.7% in older children and a higher incidence of the AML-M7 subtype at 22.5% versus 2.9% ( $p<0.001$ ). The proportion of AML-M4 was lower in younger children (7.9% vs. 12.9%;  $p<0.001$ ) (Table 4).

No significant difference in age distribution was found between sexes, although males were more common in the 1–9.9-year group, and females slightly predominated in those aged  $\geq 10$  years (Fig. 4A, Supplementary Table 3). The AML-M3 subtype was significantly more frequent in children aged  $\geq 10$  years ( $p=0.003$ ), while AML-M7 was predominantly seen in children under one year ( $p=0.022$ ) and less frequently in those aged  $\geq 10$  years ( $p<0.001$ ) (Fig. 4B, Supplementary Table 4). There was no significant association between sex and FAB subtype (Fig. 4C, Supplementary Table 5).

The proportion of AML-M4 subtype was significantly higher in children with a baseline total WBC count  $> 100 \times 10^9/L$  (40.0%) compared to those with WBC  $50\text{--}100 \times 10^9/L$  (11.8%) and  $< 50 \times 10^9/L$  (13.7%),  $p=0.039$  (Fig. 4D and Supplementary Table 6). Children presenting with proptosis had a significantly higher proportion of the AML-M5 subtype than those without proptosis (50.0% vs. 15.3%,  $p=0.013$ ) and a lower proportion of AML-M7 subtypes compared to those without proptosis (5.5% vs. 29.1%,  $p=0.048$ ) (Fig. 4E, Supplementary Table 7). No statistically significant differences were found in FAB subtype distribution based on the presence or



**Fig. 3** Trends in paediatric AML. **A.** Trend in paediatric AML by age group. **B** Trend in paediatric AML by region. **C** Regional distribution of paediatric AML by age categories. **D** Trend in Paediatric AML by sex

absence of non-orbital MS (Fig. 4E, Supplementary Table 8).

There were distinct associations between FAB subtypes and clinical variables on multivariate logistic regression. The AML-M3 subtype showed a significant correlation with age, with increased odds in older children (OR 1.20, 95% CI 1.03–1.41;  $p=0.020$ ). In contrast, the incidence of the AML-M7 subtype significantly decreased with age (OR 0.67, 95% CI 0.56–0.80;  $p<0.001$ ), indicating a higher prevalence in younger children. Proptosis was significantly associated with the AML-M5 subtype (OR 3.82, 95% CI 1.36–10.72;  $p=0.011$ ) (Table 5).

## Discussion

This study assessed the incidence and clinical characteristics of paediatric AML in Uganda, a low-income country [28]. AML diagnosis predominantly relied on morphology due to lack of capacity for cytogenetic and molecular studies, with FAB M7 and M5 being the most

common subtypes. There were significant differences in clinical characteristics between children under 10 and those 10 years and above with respect to splenomegaly, central nervous system involvement, and FAB subtype.

The estimated crude incidence of paediatric AML in Uganda of 7 per million children aged 0–17 is similar to that reported in the U.S [29], but lower than rates observed in a Brazilian study [5]. A limitation of this estimation is that this is based on hospital records and may under-represent the true incidence, particularly in a setting where children with cancer are frequently undiagnosed, misdiagnosed, or die without a definitive diagnosis [30, 31].

The median age at AML diagnosis in this cohort was 9.0 years, which was higher than reported in other African countries such as Ethiopia and Morocco [32, 33] and HIC settings such as Saudi Arabia and North America [34, 35]. Only 15.8% of patients were under two years old, with over half aged 10 years or older, contrasting

**Table 4** Clinical and biological characteristic differences between children under ten and those ten years and older

Variable	<10 years old		≥10 years old		p value
	N	(%)	N	(%)	
Sex					
Male	53	(59.6)	34	(48.6)	0.167
Female	36	(40.4)	36	(51.4)	
Region					
Central	44	(49.4)	23	(32.9)	<0.001*
Eastern	15	(16.9)	15	(21.4)	
Western	12	(13.5)	27	(38.6)	
Northern	18	(20.2)	5	(7.1)	
Clinical characteristics					
Hepatomegaly (yes)	38	(42.7)	22	(31.4)	0.144
Splenomegaly (yes)	43	(66.2)	22	(33.8)	0.031*
Lymphadenopathy (yes)	31	(34.8)	32	(45.7)	0.164
Proptosis (yes)§	22	(24.7)	13	(18.6)	0.350
Non-orbital MS (yes)	17	(19.1)	11	(15.7)	0.576
Gum hyperplasia (yes)	4	(4.5)	7	(10.0)	0.215
CNS involvement (yes)	6	(6.7)	8	(11.4)	0.014*
Nutritional status					
Normal	53	(59.6)	44	(62.9)	0.878
Moderate wasting	18	(20.2)	12	(17.1)	
Severe wasting	18	(20.2)	14	(20.0)	
Biological characteristics					
FAB subtype					
M2	5	(5.6)	5	(7.1)	<0.001*
M3	2	(2.2)	11	(15.7)	
M4	7	(7.9)	9	(12.9)	
M5	11	(12.4)	9	(12.9)	
M6	5	(5.6)	4	(5.7)	
M7	20	(22.5)	2	(2.9)	
WBC (x10 <sup>9</sup> /L)					
<50	54	(60.7)	46	(65.7)	0.513
≥50	35	(39.3)	24	(34.3)	
LDH (U/L)					
<500	7	(21.2)	13	(41.9)	0.072
≥500	26	(78.8)	18	(58.1)	
Albumin					
Normal	24	(44.4)	14	(35.9)	0.407
Low	30	(55.6)	25	(64.1)	
Cytogenetic¶					
t(8;21)	2	(40.0)	4	(80.0)	0.101
Others§	3	(60.0)	1	(20.0)	

WBC White blood cell count, LDH Lactate dehydrogenase

§Includes normal karyotype, monosomy 7 and t(2;7) and inv 9

§Unilateral and bilateral in 5 (22.7%) and 17 (77.3%) of children aged <10 years and in 2 (15.4%) and 11 (84.6%) of those aged ≥10 years, respectively

¶Only ten patients had cytogenetic testing

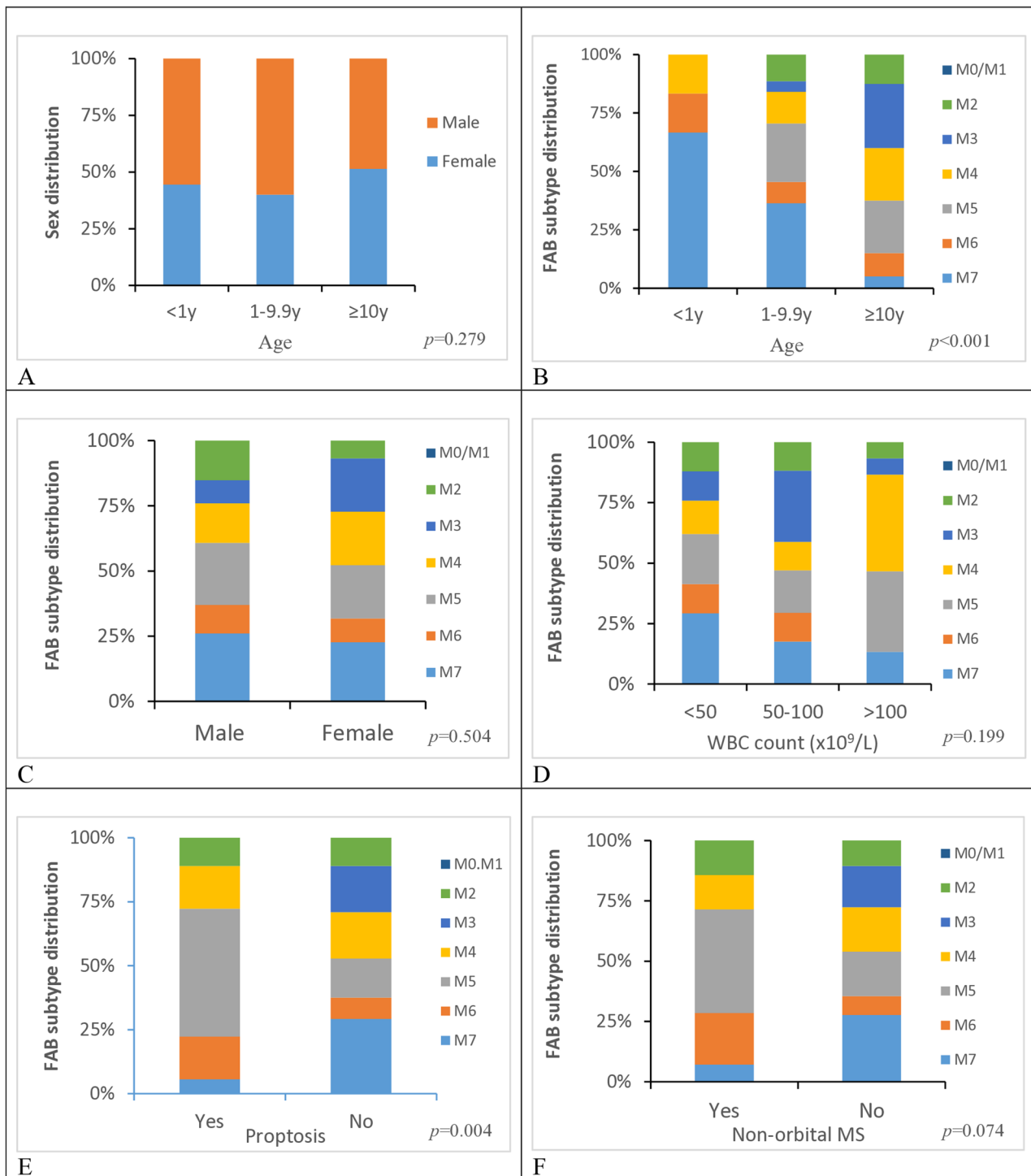
with data from France, where infants under two years accounted for approximately a quarter of paediatric AML cases [36]. Our findings align with well-documented age-related broader epidemiological patterns, with AML

described as a disease with increasing incidence in older individuals [37].

Similar to a previous finding in Ethiopia [32], this study observed geographic variation in paediatric AML cases across Uganda, with a higher proportion from the central region and fewer from the north. These disparities may reflect differences in healthcare infrastructure, referral patterns, and access to specialised oncology services, which are more established in the central region [38] – where two of the facilities were located. The regional differences could also be attributed to the fact that diagnosis in children residing far from oncology centres – a case for the northern region – could have more frequently been missed. True regional epidemiological differences cannot be excluded, but in the absence of a national population-based cancer registry, cautious interpretation of the current finding is warranted as the data are hospital-based. The absence of a national paediatric cancer registry remains a major limitation in accurately assessing the true epidemiology of paediatric AML.

The study observed a higher incidence of FAB M7 and M5 AML subtypes [19, 39]. M7 was notably more common in younger children, consistent with findings by Wan et al. in China [15]. Our result, however, is at variance with the patterns reported in many studies from the Asian context [40, 41], high-income countries [19, 34, 42, 43], and some African settings [33], where the M2 subtype usually dominates. The unusual prominence of M7 in the present study may reflect diagnostic limitations of morphology in a setting where flow cytometry was inconsistently available, as well as age-related differences, or true epidemiologic variation, which may point to underlying biological differences in disease presentation across populations. Despite the advent of molecular and cytogenetic profiling, the FAB classification remains of clinical relevance [41], particularly in resource-limited settings where access to advanced diagnostics remains constrained. As a relatively accessible, rapid, and cost-effective method, FAB subtyping can offer useful prognostic insights and has been shown to correlate with certain cytogenetic abnormalities [44]. In the present study, cytogenetic testing was performed in only 10 patients, all from a single treatment centre, with samples analysed externally, highlighting broader systemic diagnostic constraints in many LMICs [45]. This hinders accurate diagnosis, risk stratification, risk-directed therapy, and prognostic assessment, impacting disease management in these settings.

Consistent with previous studies [44], children in this cohort most commonly presented with fever, pallor or fatigue, weight loss, and bleeding, symptoms primarily resulting from disrupted haematopoiesis, including neutropenia (resulting in fever and increased susceptibility to infections), anaemia (causing pallor and fatigue),



**Fig. 4** Correlation analysis between age, sex, WBC count, proptosis, non-orbital myeloid sarcoma (MS) and FAB classification. **A** The sex distribution in age subgroups among children with AML. **B** The FAB classification distribution in age subgroups among children with AML. **C** The FAB classification distribution in sex subgroups. **D** The FAB classification distribution by WBC count categories. **E** The FAB classification distribution by presence of proptosis. **F** The FAB classification distribution by presence of non-orbital MS

and thrombocytopenia (leading to bleeding manifestations). Bone pain was reported in over a quarter of cases, a finding similar to that reported by other authors [40, 46]. Bleeding was particularly notable in patients with

the AML-M3 (acute promyelocytic leukaemia) subtype, presenting as epistaxis, gingival and subconjunctival bleeding, and, in some cases, vaginal bleeding. This finding is similar to other studies [47] and is likely due to

**Table 5** Logistic regression analysis in paediatric AML in Uganda

FAB classification	Variable	$\beta$	OR (95% CI)	<i>p</i>
M2	Age	0.079	1.08 (0.94–1.25)	0.281
	Sex: Male	0.841	2.32 (0.55–9.78)	0.253
	WBC	-0.002	1.00 (0.99–1.01)	0.767
	Proptosis: Yes	-0.373	0.69 (0.13–3.60)	0.659
M3	Age	0.186	1.20 (1.03–1.41)	0.020*
	Sex: Male	-0.748	0.47 (0.13–1.75)	0.263
	WBC	-0.008	0.99 (0.97–1.01)	0.214
	Proptosis: Yes	-	-	-
M4	Age	0.054	1.05 (0.94–1.19)	0.384
	Sex: Male	-0.375	0.69 (0.23–2.03)	0.496
	WBC	0.005	1.01 (1.00–1.01)	0.062
	Proptosis: Yes	0.076	1.08 (0.27–4.29)	0.914
M5	Age	0.023	1.02 (0.92–1.14)	0.676
	Sex: Male	-0.164	0.85 (0.32–2.28)	0.745
	WBC	0.001	1.00 (0.99–1.01)	0.691
	Proptosis: Yes	1.340	3.82 (1.36–10.72)	0.011*
M6	Age	-0.038	0.96 (0.83–1.11)	0.610
	Sex: Male	-0.127	0.88 (0.22–3.50)	0.857
	WBC	-0.009	0.99 (0.97–1.01)	0.284
	Proptosis: Yes	0.452	1.57 (0.36–6.84)	0.547
M7	Age	-0.398	0.67 (0.56–0.80)	< 0.001*
	Sex: Male	-0.557	0.57 (0.18–1.81)	0.343
	WBC:	-0.012	0.99 (0.97–1.00)	0.034*
	Proptosis: Yes	-2.202	0.11 (0.01–0.96)	0.046*

FAB French American British classification, WBC White blood cell

\*statistically significant

thrombocytopenia and disseminated intravascular coagulation (DIC), which are characteristic of AML-M3 [48]. These clinical hallmarks underscore the need for subtype-specific diagnostic awareness and prompt supportive care, particularly in resource-limited settings where advanced diagnostics may be unavailable.

The orbit is a common site for extramedullary granulocytic sarcoma in paediatric AML, typically presenting as proptosis or exophthalmos [49]. In the present cohort, proptosis occurred in over one-fifth of patients, mostly bilateral, representing a higher prevalence than the 14.7% and 9.3% previously reported by Farah et al. [49] and Sethi et al. [50], respectively. The incidence of MS is believed to be slightly higher in Africa [51] and Asia [52], with variable sex predominance [49, 51]. The finding from the present study is of clinical significance, as proptosis can be an initial or isolated manifestation of AML, often without systemic symptoms [49, 53], underscoring the need for a high index of suspicion and prompt diagnostic evaluation for AML in children presenting with orbital masses. In this study, proptosis was most commonly associated with FAB M5 and M6 subtypes, differing from other reports where M2 is more typical [49, 54]. This variation may reflect geographic or biological differences and highlights the need for further research.

CNS involvement was identified in 14.6% of children assessed, with a higher incidence among those aged  $\geq 10$  years. This rate is slightly lower than the 17.6% and 16.4%

observed in Pakistan [49] and Ethiopia [32], respectively. Our finding also contrasts several previous studies that reported a higher incidence of CNS disease in younger children and infants [39, 55, 56]—attributed to the relative immaturity of the blood-brain barrier [57] and increased vascularity of the leptomeninges in this age group [58]. The low CNS involvement rate in this study may be partly attributed to the relatively low CNS evaluation rate (60.4%), compared to higher evaluation rates (72.8% – 96.7%) in other studies [32, 55]. This finding underscores the critical need for implementing systematic CNS assessment in all paediatric AML patients to ensure accurate staging and optimised management.

### Strengths and limitations of the study

This study's principal strength lies in its multicentre design, which included the national referral treatment centre that serves patients from across the country. By focusing on a setting with limited local evidence despite bearing a significant burden of childhood cancer and associated poor outcomes, this study contributes valuable insights to an under-researched context. However, the retrospective nature of the study and its relatively small sample size limit the generalisability of the findings. Nonetheless, its multicentre nature improves the representativeness of the results. Furthermore, diagnostic capabilities were constrained by the lack of routine access to flow cytometry and cytogenetic testing, necessitating reliance on morphological classification for leukaemia diagnosis and subtyping. Similarly, the diagnosis of MS was based on clinical and radiological characteristics. This diagnostic limitation may have affected the precision of disease classification and risk stratification, including overestimation of MS incidence.

### Conclusions and recommendations

This study provides the first comprehensive overview of the clinical and biological characteristics of childhood AML in Uganda. The incidence of paediatric AML of 7.0 per million, though it aligns with global reports, could be an underestimate. The diagnosis of AML in the study setting is largely morphological due to lack of flow cytometry and cytogenetic testing. There is thus a need for improved diagnostic infrastructures to facilitate a more accurate evaluation and characterisation of paediatric AML. There were significant differences in FAB distribution by age groups, as well as variance with international literature, yet the FAB classification still provides a workable, clinically relevant basis to classify and manage paediatric AML patients in a resource-limited setting such as Uganda.

### Abbreviations

AML acute myeloid leukaemia  
ANC Absolute neutrophil count

BM	Bone marrow
ML-DS	Myeloid leukaemia of Down Syndrome
FAB	French-American-British classification
HIC	High-income country
IQR	Interquartile range
LDH	Lactate dehydrogenase
LIC	Low-income countries
LMIC	Low-and middle-income countries
MDS	Myelodysplastic syndrome
PBF	Peripheral blood film
UCI	Uganda Cancer Institute
WBC	White blood cell

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12885-026-15580-8>.

Supplementary Material 1

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### Authors' contributions

RN conceptualized and initiated the study, and contributed to the study design, data collection, and interpretation of results. JvH, JBK, MK, NN, SS contributed to the design, supervised the study, and reviewed the draft manuscript, and critically revised the manuscript. BA and JZ supervised the study and critically revised the manuscript. All authors have read and approved the final manuscript.

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### Data availability

All data relevant to the study are included in the article or uploaded as supplementary information. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

### Declarations

#### Ethics approval and consent to participate

All methods were carried out in accordance with relevant guidelines and regulations, and the study was conducted in accordance with the Declaration of Helsinki. The study was approved by the Uganda Cancer Institute Research and Ethics Committee (UCI-2024-97). The need for informed consent and assent (written or verbal) was accordingly waived by the research and ethics committee – this being a retrospective study with minimal risks.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare no competing interests.

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