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A Retrospective Cross-Sectional Cohort Study To Characterise The Demographical Profiles Of Lymphoma And Multiple Myeloma Patients At The Radiation And Isotope Centre Of Khartoum (RICK), Sudan.

Haram Awadelkarim [1], Bahariah Khalid [1*], Rahayu Mohd Eusni [2], Osama Ali Altayeb [3]

[1] Haematology Department, Faculty of Medicine and Health Sciences, University Putra Malaysia,43400 UPM Serdang, Selangor, Malaysia.
[2] Pathology Department, Faculty of Medicine and Health Sciences, University Putra Malaysia,43400 UPM Serdang, Selangor, Malaysia.
[3] Flow cytometry Department, Armed Forces Hospital.

*** Corresponding Author:** Assoc. Prof. Dr Bahariah Binti Khalid. Haematology and internal medicine, Faculty of Medicine and Health Sciences, UPM, Selangor, Malaysia
Email: bahariah@upm.edu.my

ABSTRACT

Background Lymphoma and multiple myeloma are among the most common haematological malignancies globally and pose a substantial burden on health systems, particularly in low-income countries such as Sudan.

Objective: This study aimed to describe the demographic distribution of Hodgkin's Lymphoma (HL), Non- Hodgkin's Lymphoma (NHL), and Multiple Myeloma (MM) among Sudanese patients, focusing on age, sex, and year of diagnosis, to better understand the burden of these haematological malignancies in a low-resource setting.

Materials and Methods: This retrospective cohort study analysed demographic data of patients diagnosed with HL, NHL, and MM at the Radiation and Isotope Centre of Khartoum (RICK) between 2016 and 2020. Data were obtained from hospital registries and analysed using SPSS v27.0 and R v4.4.3. Associations between disease type, age, and gender were assessed using chi-square and logistic regression analyses.

Results: Of 2,900 reviewed records, 2,741 were eligible. Males constituted 59.9% (n = 1,645), with a male-to- female ratio of 1.5:1. HL was the most common (38.2%), followed by NHL (35.5%) and MM (26.3%). Gender was not significantly associated with malignancy type ($p = 0.359$), while age distribution differed significantly ($p < 0.001$), with HL predominating among younger patients and NHL/MM in older adults.

Conclusion HL, NHL, and MM represent the most prevalent haematological malignancies treated at Sudan's national referral centre. Their demographic distribution varies significantly with age but not with gender. These findings highlight the need for targeted resource allocation and awareness strategies based on age-specific risk profiles in the Sudanese population.

Keywords: Hodgkin's lymphoma, non-Hodgkin's lymphoma, multiple myeloma, epidemiology, Sudan

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1. INTRODUCTION

Haematological malignancies are diseases characterised by the clonal proliferation of blood-forming cells in the blood, bone marrow, or lymphoid tissues. They are broadly classified into leukaemia, lymphoma, and Multiple Myeloma (MM). [1] These malignancies are among the most prevalent cancers worldwide, according to the Centers for Disease Control and Prevention (CDC), [2] and impose a significant burden on already limited health systems in low-income countries such as Sudan. Accurate population-level data are essential to allocate resources effectively and reduce morbidity and mortality. However, Sudan lacks comprehensive national cancer data due to the absence of a national registry, limited healthcare infrastructure,

underreporting, and challenges in data collection caused by political instability and resource constraints. [3] Consequently, hospital-based studies remain the most reliable source of information.

Lymphoma is a malignant proliferation of lymphoid tissues. It is classified into two main subtypes: Hodgkin's Lymphoma and Non-Hodgkin's Lymphoma. [4] According to reports from the International Agency for Research on Cancer (IARC), the incidence rate of lymphoma is 3.5% of all cancers, with 589,580 new patients worldwide in 2018 and 274,891 deaths from the disease. [5]

MM is the most serious and prevalent type of plasma cell dyscrasia. In particular, MM is the second most common haematological malignancy of the elderly and accounts for approximately 1% of all cancers and 10% of haematological neoplasms. [6,7,8] It is characterised by the presence of > 10% of clonal bone marrow plasma cells (based on a morphological assessment) or biopsy-proven plasmacytoma with a concentration of > 30 g/L and evidence of organ and tissue damage. [6] Furthermore, myeloma is virtually always preceded by an asymptomatic premalignant stage termed Monoclonal Gammopathy of Undetermined Significance (MGUS), progresses through

smouldering (asymptomatic) myeloma, and finally becomes overt (symptomatic) myeloma, resulting in BM infiltration and osteolytic lesions. [9]

A hospital-based survey in Sudan from 2009–2013 showed lymphoma as the fourth most prevalent cancer in adults and second in children. [10] According to IARC WHO – Sudan Globocan 2020, NHL ranks 2nd (5.5%), leukaemia 4th (4.7%), MM 20th (1.2%),

and HL 21st (1.2%). [11]

This study aims to determine the epidemiological details of the second most prevalent haematological malignancy (HL, NHL, and MM) among Sudanese patients attending RICK based on demographic data (age, gender, and year of diagnosis) from 2016 to 2020.

2. METHODS

A retrospective descriptive hospital-based study was conducted using data from the Radiation and Isotope Centre of Khartoum (RICK), Sudan, the country's primary referral centre for haematological malignancies, covering the period from January 2016 to December 2020. All patients admitted with a confirmed diagnosis of Hodgkin's Lymphoma (HL), Non-Hodgkin's Lymphoma (NHL), or Multiple Myeloma (MM) were included, resulting in a total of 2,741 cases. Patients with incomplete records or unconfirmed diagnoses were excluded.

Diagnoses were established according to the World Health Organisation (WHO) classification of haematopoietic and lymphoid tumours (4th edition, 2008; updated in WHO HAEM5, 2022) and confirmed by histopathological examination and clinical investigations. No patient was classified under more than one disease category.

Data were extracted manually from hospital registry logbooks using a standardised data abstraction form capturing demographics (age, sex) and confirmed diagnoses. Data quality was ensured through double entry and independent verification by two researchers, with discrepancies resolved by consensus. Age at diagnosis was recorded as documented in the registry without recalculation.

Statistical analysis was performed using *SPSS version 27.0 and R software version*

4.4.3. Descriptive statistics, including frequencies and percentages, were used to summarise the prevalence of HL, NHL, and MM. Age was categorised into clinically relevant groups: 1–4, 5–14, 15–24, 25–44, 45–59, and ≥60 years. Associationsbetween malignancy types and age or gender were evaluated using chi-square tests, with a significance threshold of $p < 0.05$. Multiple logistic regression models estimated the odds of NHL versus HL and MM versus HL, using age, gender, and year of diagnosis as independent variables. Temporal trends across the study years were visualised and summarised.

Missing data were excluded from analyses. No subgroup or sensitivity analyses were performed due to the retrospective and single-centre design. Limitations include potential selection bias, incomplete records, and the absence of treatment or outcome data. Given the political instability in Sudan, cross-validation with national registries was not feasible.

Ethical approval was obtained from the Khartoum Ministry of Health Research Department on 22 August 2021. The ethics committee waived informed consent because the study used routinely collected anonymised hospital data. Data are not publicly available due to confidentiality, but may be shared in de-identified form upon reasonable request and institutional approval.

3. RESULTS

A total of 2,741 diagnosed cases with specific haematological malignancies (HL, NHL, and MM) were included in this study. Their data were extracted from the RICK hospital registry over five years, between January 2016 and December 2020. The most frequent type among these neoplasms appears to be HL (38.2% n = 1,046), followed by NHL (35.5% n = 974), and the least frequent type is MM (26.3% n = 721), as shown in Table (1).

Medical data revealed overall dominance of males diagnosed with these neoplasms (59.9% n = 1,645) over females (41.1% n = 1,096) with a male-to-female ratio (1.5:1). The p-value of 0.359 indicates that the proportional distribution of malignancies within each gender is comparable Table (2), This suggests that gender was not significantly associated with the type of haematological malignancy in this study population. The gender distribution over each type varies, as displayed below in Figure 1.

Age at diagnosis was categorised into six groups: 1–4, 5–14, 15–24, 25–44, 45–59, and ≥60 years. The 45–59 years group represented the largest proportion overall (44.3%, n = 1,215). The mean age was 9.6 years for patients <18 years and 50.7 years

for patients ≥18 years. A chi-square test demonstrated a statistically significant association between age group and malignancy type ($p < 0.001$) (Table 3).

Specifically, MM cases were predominantly in older adults: 55% aged 45–59 and 32%

≥60 years. NHL cases were similarly concentrated in older adults but more broadly distributed: 47% in the 45–59 age group and 20% ≥60 years. In contrast, HL cases were more evenly distributed across age groups, with noticeable proportions among younger patients: 5–14 years (13%) and 15–24 years (11%).

The temporal distribution of cases over the five-year study period showed a peak in 2018 for all three malignancy types ‘’Figure (2), Table (4)’’. Additional analyses, including the association between malignancy types and year of diagnosis, are presented in Table (4).

Multiple logistic regression models were applied to estimate the odds of having NHL versus HL and MM versus HL, based on the independent variables of the study, such as age and gender, Tables (5) and (6). These findings indicate that age is a significant predictor of haematological malignancy type, with older patients more likely to be diagnosed with MM or NHL than with HL. Gender did not significantly influence the type of diagnosis in either model.

Given the absence of reliable population-level denominators, the findings represent hospital-based relative burden rather than true incidence or prevalence rates. Future studies should integrate registry data with population census data to allow accurate epidemiological calculations

Table 1: Prevalence Of HL, NHL, And MM Cases.

Characteristic	**Overall N = 2,7411**	**95% CI**	**Male N = 1,6451**	**95% CI**	**Female N = 1,0961**	**95% CI**
Disease						
Multiple Myeloma (MM)	721	25%, 28%	447	25%, 29%	274	22%, 28%
	(26%)		(27%)		(25%)	
Non-Hodgkin’s Lymphoma	974	34%, 37%	585	33%, 38%	389	33%, 38%
(NHL)	(36%)		(36%)		(35%)	
Hodgkin’s Lymphoma (HL)	1,046	36%, 40%	613	35%, 40%	433	37%, 42%
	(38%)		(37%)		(40%)	
1n (%)						
Abbreviation: CI = Confidence Interval						

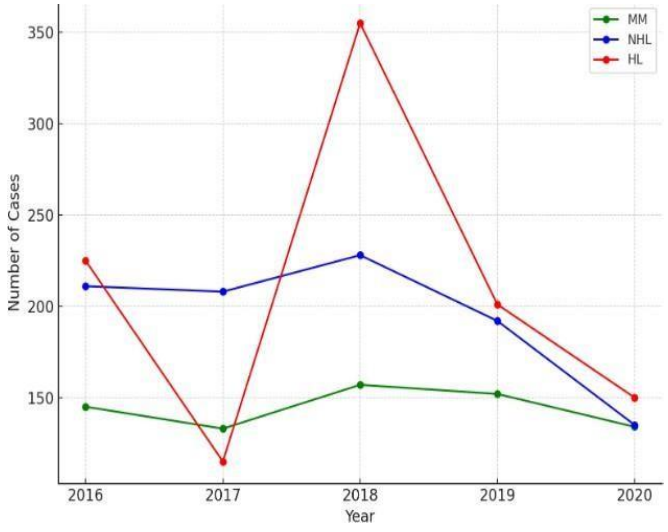
Table 2: Association Between HL, NHL, And MM Cases, with Gender.

	Male n (%)	Female n (%)	Total n (%)	p- value1
Disease				**0.359**
Multiple Myeloma (MM)	447 (68.0%)	274 (32.0%)	721 (26.3%)	
Non-Hodgkin's Lymphoma (NHL)	585 (60.1%)	389 (39.9%)	974 (35.5%)	
Hodgkin's Lymphoma (HL)	613 (58.6%)	433 (41.4%)	1,046 (38.2%)	
Total	1,645 (59.9%)	1,096 (40.1%)	2,741 (100%)	
1Chi-squared test p-value set at < 0.005				

Table 3: Association of HL, NHL, and MM with age groups.

Age								
	1-4 years	**5-14 years**	**15-24 years**	**25-44 years**	**45-59 years**	**≥ 60 years**	**Total**	**p-value1**
Disease								**<0.001**
Multiple Myeloma (MM)	1 (0.1%)	1 (0.1%)	8 (1.1%)	87 (12%)	394 (55%)	230 (32%)	721 (26.3%)	
Non-Hodgkin's Lymphoma (NHL)	17 (1.7%)	53 (5.4%)	68 (7.0%)	183 (19%)	459 (47%)	194 (20%)	974 (35.5%)	
Hodgkin's Lymphoma (HL)	63 (6.0%)	134 (13%)	114 (11%)	186 (18%)	362 (35%)	187 (18%)	1,046 (38.2%)	
Total	81 (3.0%)	188 (6.9%)	190 (6.9%)	456 (17%)	1,215 (44%)	611 (22%)	2,741 (100%)	
1Pearson's Chi-squared test								

Figure 1: Annual Distribution Of HL, NHL, And MM Diagnoses (2016 - 2020).



Note: Line graph showing the annual trends of HL, NHL, and MM diagnoses. Peak observed in 2018, with a decline in 2019–2020 **Table 4:** Association of HL, NHL, and MM with year of diagnosis.

Year							
	2016	**2017**	**2018**	**2019**	**2020**	**Total**	**p- value1**
Disease							**<0.001**
Multiple Myeloma (MM)	145 (20%)	133 (18%)	157 (22%)	152 (21%)	134 (19%)	721 (26.3%)	
Non-Hodgkin's Lymphoma (NHL)	211 (22%)	208 (21%)	228 (23%)	192 (20%)	135 (14%)	974 (35.5%)	
Hodgkin's Lymphoma (HL)	225 (22%)	115 (11%)	355 (34%)	201 (19%)	150 (14%)	1,046 (38.2%)	
Total	581 (21%)	456 (17%)	740 (27%)	545 (20%)	419 (15%)	2,741 (100%)	
1Pearson's Chi-squared test							

Table 5: Multiple Logistic Regression: odds of NHL versus HL.

Characteristic	**OR**	**95% CI**	**p-value**
Gender (Female vs Male)	0.94	0.78–1.13	0.50
Age 5–14 vs 1–4	1.42	0.77–2.73	0.30
Age 15–24 vs 1–4	2.45	1.33–4.66	0.005
Age 25–44 vs 1–4	4.07	2.32–7.48	<0.001
Age 45–59 vs 1–4	4.69	2.73–8.46	<0.001
Age ≥60 vs 1–4	4.82	2.74–8.89	<0.001
Year 2017 vs 2016	2.08	1.54–2.82	<0.001
Year 2018 vs 2016	0.67	0.52–0.88	0.004

Year 2019 vs 2016	1.02	0.76–1.37	0.90
Characteristic	**OR**	**95% CI**	**p-value**
Year 2020 vs 2016	1.06	0.77–1.45	0.70
Abbreviations: CI = Confidence Interval, OR = Odds Ratio			

Table 6: Multiple Logistic regression: odds of MM versus HL.

Characteristic	**OR**	**95% CI**	**p-value**
Gender (Female vs Male)	0.88	0.71–1.10	0.30
Age 5–14 vs 1–4	0.43	0.02–11.0	0.60
Age 15–24 vs 1–4	5.23	0.92–98.5	0.12
Age 25–44 vs 1–4	36.2	7.73–646	<0.001
Age 45–59 vs 1–4	74.1	16.1–1,315	<0.001
Age ≥60 vs 1–4	98.8	21.3–1,760	<0.001
Year 2017 vs 2016	2.26	1.57–3.27	<0.001
Year 2018 vs 2016	0.65	0.47–0.90	0.009
Year 2019 vs 2016	1.09	0.77–1.55	0.60
Year 2020 vs 2016	1.57	1.08–2.28	0.018
Abbreviations: CI = Confidence Interval, OR = Odds Ratio			

4. DISCUSSION

This study provides a five-year overview of HL, NHL, and MM cases at RICK, Sudan, highlighting their demographic characteristics and temporal trends. HL emerged as the most common malignancy (38.2%), contrasting with previous reports at RICK, where NHL predominated. This discrepancy likely reflects differences in study periods, inclusion criteria, and data collection methods (Abdalhabib et al., 2018) A male predominance was observed, consistent with global and regional trends in haematological malignancies (Swedish Lymphoma Register; multiple myeloma registries) [14,15]. This sex disparity may be influenced by biological, environmental, and healthcare access factors, particularly in low- and middle-income countries.

The age distribution followed expected patterns, with HL predominating in younger individuals, while NHL and MM were more common among older adults. MM incidence peaked in the 45–59 age group, consistent with regional data from Egypt and Saudi Arabia.[16,17] Comparable trends have been reported in Eastern Morocco and other settings, demonstrating HL predominance in adolescents and young adults, and a marked increase in NHL and MM with advancing age. [18] Interestingly, 13.5% of MM cases occurred in patients younger than 45 years, highlighting a potential unique risk profile in the Sudanese population. Cases of MM in children under four years were reported, though these are likely due to misclassification or diagnostic errors inherent in retrospective data. Globally, most MM cases occur in individuals aged

60–70 and older, with only a small proportion diagnosed under 50, often exhibiting more favourable clinical features [19]. Differences between our findings and those from higher- income countries may reflect variations in demographic structure, healthcare access, and diagnostic capacity. Overall, these age-pattern trends support existing evidence while underscoring the need for improved early detection strategies for older MM and NHL patients in the region.

Temporal trends showed fluctuations in case numbers, with a peak in 2018 and a decline in 2019**,** reflecting the effects of political instability and economic challenges on diagnostic capacity, patient referral, population health factors and registry maintenance. These findings underscore the fragility of hospital-based cancer registries in Sudan and the urgent need for robust, digitised, and decentralised data systems.

Limitations of the study include its retrospective single-centre design, incomplete clinical and treatment data, absence of staging and survival outcomes, and potential misclassification errors. Nevertheless, this analysis provides the most comprehensive snapshot of HL, NHL, and MM epidemiology in Sudan to date and highlights demographic patterns essential for healthcare planning and resource allocation

The study emphasises the critical need to preserve and publish hospital-based data, especially following the April 2023 armed conflict, which resulted in the loss of extensive medical registries in Khartoum and other regions. Documenting existing data is vital to inform policy, clinical practice, and future epidemiological studies in Sudan.

5. CONCLUSION

This study complements previous research that aimed to demonstrate the actual situation of various types of haematological malignancies in Sudan, as it highlights the distribution. It also examines the patterns of HL, NHL, and MM, the second most prevalent haematological malignancies after leukaemia, with their demographic details based on one of the best available data sources, which shows a progressive increase over time, which is aligned with the CDC report.

The distribution of cases over a five-year duration reveals that Sudan's political and economic situation affects the registry's sustenance, which is crucial to measuring the outcome and the cost-benefit analysis of cancer treatment in Sudan.

With the sudden beginning of major armed conflict in Khartoum and many other districts in Sudan on the 15th of April 2023, and the accompanying extensive loss of a huge medical registration archive in almost all hospitals in Khartoum, including RICK, all researchers must preserve and publish all available information on diseases they handle.

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Ethics approval: Ethical approval for this study was obtained from the Khartoum Ministry of Health Research Department, Sudan, on 22 August 2021.

Patient consent: Not applicable. The ethics committee waived the requirement for informed participant consent due to the nature of the study and the use of routinely collected hospital data. All data were anonymised before being accessed and analysed by the study authors to ensure patient confidentiality.

Provenance and peer review Not commissioned, externally peer reviewed

Data availability: The data supporting this study's findings are not publicly available due to patient confidentiality and institutional restrictions. However, de-identified data may be made available upon reasonable request and subject to the approval of the Khartoum Ministry of Health and RICK. Data sharing will comply with ethical guidelines and institutional data-sharing agreements that protect patient privacy.

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