Journal of Blood Medicine

Dovepress
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ORIGINAL RESEARCH

Haematological Profile of Patients with Sickle Cell Disease in the Acholi Sub-Region, Uganda

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Background: Sickle cell disease (SCD) is a genetic blood disorder most prevalent in Eastern and Western Africa. With the high prevalence of SCD in northern Uganda, we set out to document the haematological profile of patients with SCD in Acholi sub-region of northern Uganda.

Methods: This was a cross-sectional study at Gulu University Teaching Hospitals from February to May 2025. Patients with SCD gave blood, which was analysed at GRRH, and the results were shared with their healthcare providers. Logistic regression was done to determine the association between the haematological parameters and hydroxyurea use.

Results: Four hundred eighteen blood samples were analysed. The mean age of the participants was seven years of age, and the median was 5 years of age, ranging from 1 to 28 years of age. About 95% of participants had anaemia, 92.1% erythropenia, and 92.6% low haemtocrit levels. Meanwhile, 47.9% of participants had leucocytosis and 49.1% thrombocytosis. Hydroxyurea use was associated with a normal platelet count (OR=0.35, 95% CI 0.18–0.65, p-value=0.001).

Conclusion: In patients with sickle cell disease, there were increased white blood cells, platelets, and low red blood cells. That may reflect increased haemolytic activities that destroy the sickled red blood cells in low oxygen tension. Hydroxyurea use was associated with normal platelet counts.

Keywords: sickle cell disease, full haemogram, acholi sub-region, Uganda, Africa

Introduction

Sickle cell disease (SCD) is a genetic blood disorder that reduces the flexibility of the red blood cells under low oxygen tension in end organs, leading to "sickling" of the red blood cells and acute vaso-occlusive pain, tissue ischaemia and poor growth.[1,2] Five per cent of the world's population has at least one genetic mutation that causes haemoglobinopathies.[3,4] The prevalence of SCD is higher at 20–30% in Western and Eastern Africa.[3,4]

In this region, SCD was first documented in 1949.[5] By 2015, the prevalence of sickle cell trait was 13.3% in Uganda,[6,7] with northern Uganda having 19.2% for sickle cell trait and 1.3% for sickle cell disease at birth.[6] In western Kenya, sickle cell disease affects 4.5% of newborns[8] while it affects 3.5% in South Sudan.[9] That is a significant cause of mortality in children under five,[6,10,11] necessitating more comprehensive research efforts to improve treatment outcomes.

Niprisan, an antisickling agent (made from pepper seeds, clove flower buds, caprium stem, sorghum leaves and "trona")[12] and *Cajanus cajan* (pigeon peas)[13] are frequently used to treat sickle cell disease (SCD) in Nigeria. Some foods like pigeon peas (*Cajanus cajan*), pepper, wild fruits and sorghum are staples in the Acholi sub-region.[14,15] These foods perhaps mask the early manifestations of SCD and may explain the high prevalence of sickle cell traits and disease in the Acholi sub-region. This may also mask the haematological parameters of people with SCD.

https://doi.org/10.2147/JBM.S558610
Received: 5 August 2025
Accepted: 11 February 2026
Published: 17 February 2026

In western Kenya, people with HbSS had reduced haemoglobin and red blood cell count and leucocytosis.[16] This was similar to the findings in Gabon and Ghana.[17,18] With the high prevalence of SCD in northern Uganda, and the staple foods of the Acholi people used as treatment for SCD in other parts of Africa, it was necessary to document the haematological parameters of patients with SCD attending the SCD clinics at the Gulu University Teaching Hospitals.

Methods

This was a cross-sectional study at Gulu University's teaching hospitals (Gulu Regional Referral Hospital (GRRH) and St. Mary's Hospital Lacor). GRRH is a government of Uganda regional referral hospital for the Acholi sub-region with a bed capacity of 500, located at the heart of Gulu City. St. Mary's Hospital Lacor is a private, not-for- profit hospital founded by the Catholic Church, located six kilometres west of Gulu town along Juba Road in the Gulu district (Longitude 30–32 degrees East and Latitude 02–04 degrees North), with a bed capacity of 482.

These are the only centers with sickle cell clinics in the Acholi sub-region from the 1st February to 31st May 2025. All those patients with SCD were targeted, and those with a confirmed diagnosis of SCD were included. Confirmation of the diagnosis of SCD was done either through haemoglobin electrophoresis or the sickling test with sodium metabisulphite.

Using Kish and Leslie formula for calculating sample size for cross-sectional studies, sample size

$$n = \frac{z^2 p(1-p)}{e^2},$$

where z is the z-score for the 95% confidence level, value is 1.96

p is the proportion with haematological disorders, assumed 50%

q is the proportion without haematological disorders, assumed 50%

e is the margin of error of 5%

Therefore, n=1.96 × 1.96 (1–0.5) × 0.5/(0.05 × 0.05) = 384.16

The estimated sample size is 385 participants, and 10% (39 participants) was added for attrition. The overall estimated sample size was 424 participants.

All the patients who came to the SCD clinic were approached and informed about the study and requested to give written informed consent. The participants who were 8–18 years gave ascent and their parents/guardians gave written informed consent. Those participants below 8 years without guardians or those who could not understand English or Acholi languages were excluded from the study.

A venipuncture was done, and 1–2 militers of blood were collected in EDTA bottles. The samples were taken to GRRH Clinical Laboratory and analysed using a haematology analyser equipment, Cell-Dyn Ruby, software version 2.3 ML, analyser S/N 72045BG (CD-RUBY) manufactured by Abbot Laboratories in the United States of America and calibrated to give reference values as well. For quality control, the Abbott CELL-DYN Ruby haematology analyser is equipped with software and a reference sample that is run daily to ensure the analyser is functioning properly and is well-calibrated. The results were printed and shared with the healthcare professionals taking care of the patients. Very sick (anaemic) patients, according to the Uganda clinical guidelines,[19] were referred to the wards for further management.

The data was entered in Microsoft Excel, and analysed into proportions, means, median, standard deviations and interquartile range in RStudio version 4.5.1. The Shapiro–Wilcoxon test was done to assess whether the parameters were normally distributed. Summary statistics were entered into tables. Bivariable analysis was done against hydroxyurea and age under five. Those variables with $p<0.2$ were taken for multivariable analysis. Those variables with $p<0.05$ at multivariable analysis were independently related to hydroxyurea or age under five years.

Results

Four hundred eighteen participants had complete data for use of hydroxyurea from the sickle cell clinics. Those without the use (or non-use) of hydroxyurea were not used in the data analysis. There were 206 (49.3%) females and 212 (50.7%) males, with a mean age of 7 years, a median of 5, and a range of 1 to 28 years. Three hundred sixty-three (86.8%) of the participants were on hydroxyurea, while nine (2.2%) were on folic acid alone. The rest (11%) were not yet started on any medication. Most of the patients were anaemic (Hb < 11.00 g/dL), had leukocytosis and thrombophilia. The details of full

Table 1 Mean (sd) and Median (IQR) for the Haematological Parameters of People with Sickle Cell Disease in Acholi Sub-Region of Northern Uganda

Variable	Mean (sd)	Median (IQR)
White Blood Cell Count $\times 10^3$	13.74 (13.38)	10.70 (6.68–15.80)
Neutrophils Count $\times 10^3$	3.96 (2.85)	3.4 (1.75–5.55)
Lymphocytes Count $\times 10^3$	8.08 (11.54)	5.03 (2.77–8.52)
Monocytes Count $\times 10^3$	0.82 (0.96)	0.53 (0.22–1.07)
Eosinophils Count $\times 10^3$	0.46 (0.61)	0.25 (0.11–0.59)
Basophils Count $\times 10^3$	0.49 (0.87)	0.23 (0.10–0.53)
Red blood cell count $\times 10^6$	2.84 (0.79)	2.70 (2.38–3.14)
Haemoglobin level (g/dL)	8.04 (1.62)	7.88 (7.12–8.77)
Haematocrit (%)	26.04 (7.53)	25.30 (22.40–28.30)
Mean corpuscular volume (fL)	92.59 (11.63)	92.45 (85.00–99.80)
Mean corpuscular haemoglobin (pg)	29.01 (4.38)	28.85 (26.20–31.90)
Mean corpuscular haemoglobin concentration (g/dL)	31.30 (2.56)	31.10 (30.00–32.30)
Red cell distribution width (%)	21.96 (3.87)	21.40 (19.30–24.20)
Platelets (μL)	462.24 (217.38)	443.50 (322.0–551.00)
Mean platelet volume (fL)	6.11 (1.28)	5.82 (5.23–6.66)

Abbreviations: sd= standard deviation, IQR = Interquartile range.

hemograms of patients are shown in Tables 1 and 2. The Shapiro–Wilcoxon test revealed the haematological parameters were not normally distributed.

T-tests in Table 3 revealed that people on hydroxyurea were younger and had higher platelet counts, findings similar to those from the Mann–Whitney *U*-tests in Table 4.

Table 2 Haematological Parameters of People with Sickle Cell Disease in Acholi Sub-Region

Variable	Variable Category	Frequency	Percentage
White Blood Cell Count $\times 10^3$	> 11.00	200	47.9
	4.00–11.00	184	44.0
	< 4.00	34	8.1
Neutrophils Count $\times 10^3$	> 7.00	50	12.0
	1.50–7.00	282	67.5
	< 1.50	86	20.5
Lymphocytes Count $\times 10^3$	> 4.00	263	62.9
	1.20–4.00	130	31.1
	< 1.20	25	6.0

(*Continued*)

Table 2 (Continued).

Variable	Variable Category	Frequency	Percentage
Monocytes Count $\times 10^3$	> 1.00	112	26.8
	0.20–1.00	210	50.2
	< 0.20	96	23.0
Eosinophils Count $\times 10^3$	> 4.00	1	0.2
	0.02–4.00	400	95.7
	< 0.02	17	4.1
Basophils Count $\times 10^3$	> 0.10	313	74.9
	0.00–0.10	105	25.1
Platelets (μL)	> 450	205	49.1
	150 - 450	202	48.3
	< 150	11	2.6
Mean platelet volume (fL)	9.00–13.00	19	4.5
	< 9.00	399	95.5
Red blood cell count $\times 10^6$	> 6.00	0	0.0
	4.10–6.00	33	7.9
	< 4.10	385	92.1
Haemoglobin level (g/dL)	11.00–17.50	21	5.0
	< 11.00	397	95.0
Haematocrit (%)	> 45.00	6	1.4
	35.00–45.00	25	6.0
	< 35.00	387	92.6
Mean corpuscular volume (fL)	> 100	98	23.4
	80.00–100.00	265	63.4
	< 80.00	55	13.2
Mean corpuscular haemoglobin (pg)	> 32.00	100	23.9
	27.00–32.00	195	46.7
	< 27.00	123	29.4
Mean corpuscular haemoglobin concentration (g/dL)	> 35.00	17	4.1
	33.00–35.00	56	13.4
	< 33.00	345	82.5
Red cell distribution width (%)	> 17.00	383	91.6
	12.00–17.00	35	8.4

Table 3 *T*-Test for Haematological Parameters Comparing People with SCD Taking Hydroxyurea and Those on Other Medications in Acholi Sub-Region of Northern Uganda

Variable	No Hydroxyurea (55)		Taking Hydroxyurea (363)		*p-Value*
	Mean	Standard Deviation (sd)	Mean	Standard Deviation (sd)	
Age	10.87	0.97	6.34	0.24	0.000
White Blood Cell Count $\times 10^3$	12.90	1.46	13.66	0.72	0.621
Neutrophils Count $\times 10^3$	4.11	0.38	3.94	0.14	0.685
Lymphocytes Count $\times 10^3$	7.03	1.23	8.24	0.56	0.469
Monocytes Count $\times 10^3$	0.82	0.10	0.82	0.52	0.978
Eosinophils Count $\times 10^3$	0.43	0.08	0.47	0.03	0.666
Basophils Count $\times 10^3$	0.58	0.09	0.48	0.04	0.451
Red blood cell count $\times 10^6$	2.84	0.12	2.84	0.04	0.939
Haemoglobin level (g/dL)	8.04	0.21	8.04	0.09	0.999
Haematocrit (%)	25.99	0.81	26.04	0.37	0.965
Mean corpuscular volume (fL)	93.97	1.90	92.59	0.57	0.335
Mean corpuscular haemoglobin (pg)	29.37	0.63	28.96	0.23	0.521
Mean corpuscular haemoglobin concentration (g/dL)	31.41	0.30	31.30	0.13	0.742
Red cell distribution width (%)	21.17	0.52	21.96	0.19	0.107
Platelets (µL)	398.82	19.31	471.84	11.81	0.020
Mean platelet volume (fL)	6.13	0.16	61.06	0.07	0.861

Table 4 Mann–Whitney Test for Haematological Parameters Comparing People with SCD Taking Hydroxyurea and Those on Other Medications in Acholi Sub-Region of Uganda

Variable	No Hydroxyurea (55)		Taking Hydroxyurea (363)		*p-value*
	Median	Interquartile Range (IQR)	Median	Interquartile Range (IQR)	
Age	10.00	5 00–16.00	5.00	3.00–9.00	0.000
White Blood Cell Count $\times 10^3$	10.30	6.69–16.20	10.70	6.66–15.80	0.882
Neutrophils Count $\times 10^3$	3.38	1.67–5.92	3.37	1.77–5.55	0.666
Lymphocytes Count $\times 10^3$	4.87	3.01–8.09	5.03	2.75–8.53	0.859
Monocytes Count $\times 10^3$	0.68	0.21–1.25	0.52	0.23–1.07	0.620
Eosinophils Count $\times 10^3$	0.21	0.09–0.53	0.26	0.11 - −0.61	0.343
Basophils Count $\times 10^3$	0.32	0.13–0.83	0.22	0.09–0.51	0.021
Red blood cell count $\times 10^6$	2.62	2.29–3.12	2.70	2.38–3.24	0.660
Haemoglobin level (g/dL)	7.81	7.02–8.82	7.88	7.12–8.77	0.948

(*Continued*)

https://doi.org/10.2147/JBM.S558610

Table 4 (Continued).

Variable	No Hydroxyurea (55)		Taking Hydroxyurea (363)		*p-value*
	Median	Interquartile Range (IQR)	Median	Interquartile Range (IQR)	
Haematocrit (%)	25.20	22.00–28.10	25.40	22.40–28.3	0.819
Mean corpuscular volume (fL)	91.70	85.40–98.00	92.50	84.90–100.00	0.777
Mean corpuscular haemoglobin (pg)	29.20	26.10–32.30	28.80	26.20–31.90	0.594
Mean corpuscular haemoglobin concentration (g/dL)	31.40	30.10–32.30	31.00	30.00–32.30	0.619
Red cell distribution width (%)	20.50	18.80–23.20	21.60	19.40–24.60	0.068
Platelets (µL)	393.00	290 - 478	455.00	335 - 554	0.012
Mean platelet volume (fL)	5.91	5.38–6.66	5.79	5.22–6.66	0.588

T-tests, in Table 5, revealed that the children under five years had a higher red blood cell count. However, they had lower mean corpuscular volume, mean corpuscular haemoglobin, and platelet count, which were similar to the Mann–Whitney *U*-tests outlined in Table 6. There was no difference in the haemogram between male and female patients.

Bivariable and multivariable logistic regression analyses revealed strong associations between platelet count and age with hydroxyurea use, as shown in Tables 7 and 8. Logistic regression also revealed that people under five years had normal eosinophil count and normal mean corpuscular haemoglobin. However, they were not on hydroxyurea as shown in Tables 9 and 10.

Table 5 *T*-Test for Haematological Parameters Comparing People with SCD Under Five and Those at Least Five years Old in the Acholi Sub-Region of Northern Uganda

Variable	Under 5 Years (n=176)		At Least 5 Years (n=242)		*p-value*
	Mean	Standard Deviation (sd)	Mean	Standard Deviation (sd)	
White Blood Cell Count $\times 10^3$	13.15	0.84	14.17	0.95	0.4423
Neutrophils Count $\times 10^3$	3.93	0.21	3.99	0.14	0.8415
Lymphocytes Count $\times 10^3$	7.59	0.73	8.44	0.82	0.4561
Monocytes Count $\times 10^3$	0.79	0.07	0.84	0.06	0.6466
Eosinophils Count $\times 10^3$	0.54	0.05	0.41	0.04	0.0288
Basophils Count $\times 10^3$	0.40	0.05	0.56	0.06	0.0784
Red blood cell count $\times 10^6$	2.96	0.06	2.75	0.04	0.0058
Haemoglobin level (g/dL)	8.11	0.13	8.00	0.10	0.4883
Haematocrit (%)	26.07	0.46	26.04	0.37	0.9441
Mean corpuscular volume (fL)	89.91	0.81	94.54	0.57	0.0000
Mean corpuscular haemoglobin (pg)	28.11	0.33	29.67	0.21	0.0003
Mean corpuscular haemoglobin concentration (g/dL)	31.15	0.23	31.41	0.13	0.3156
Red cell distribution width (%)	22.29	0.31	21.96	0.19	0.1335
Platelets (µL)	428.23	12.61	462.97	10.63	0.0062
Mean platelet volume (fL)	6.07	0.10	6.11	0.08	0.5861

Table 6 Mann Whitney Test for Haematological Parameters Comparing People with SCD Under Five and Those at Least Five years Old in Acholi Sub-Region of Northern Uganda

Variable	Under 5 Years (n=176)		At Least 5 Years (n=242)		*p-value*
	Median	Interquartile Range (IQR)	Median	Interquartile Range (IQR)	
White Blood Cell Count $\times 10^3$	10.80	6.55–16.85	10.60	6.77–15.20	0.911
Neutrophils Count $\times 10^3$	3.26	1.77–5.62	3.42	1.75–5.47	0.773
Lymphocytes Count $\times 10^3$	5.02	2.75–8.89	5.06	2.87–8.40	0.864
Monocytes Count $\times 10^3$	0.51	0.20–1.04	0.55	0.24–1.10	0.259
Eosinophils Count $\times 10^3$	0.29	0.11–0.75	0.24	0.11–0.49	0.286
Basophils Count $\times 10^3$	0.21	0.09–0.46	0.24	0.11–0.61	0.211
Red blood cell count $\times 10^6$	2.77	2.48–3.39	2.63	2.31–3.01	0.006
Haemoglobin level (g/dL)	7.96	7.10–8.79	7.83	7.18–8.77	0.563
Haematocrit (%)	25.90	22.50–28.80	25.05	22.40–28.00	0.233
Mean corpuscular volume (fL)	89.35	82.55–96.65	94.40	86.70–103.00	0.000
Mean corpuscular haemoglobin (pg)	27.85	25.40–30.40	29.35	27.30–32.30	0.000
Mean corpuscular haemoglobin concentration (g/dL)	130.90	29.75–32.10	31.25	30.20–32.40	0.027
Red cell distribution width (%)	21.90	19.55–25.30	21.25	19.20–23.70	0.091
Platelets (μL)	414.50	300.50–531.00	462.50	354.00–581.00	0.007
Mean platelet volume (fL)	5.76	5.09–6.51	5.88	5.35–6.69	0.186

Table 7 Univariable Analysis of Haematological Profiles for Participants on Hydroxyurea

Variable	Variable Category	Odds Ratio	p-value
White Blood Cell Count $\times 10^3$	> 11.00	1.10	0.850
	4.00–11.00	1.21	0.724
	< 4.00	1.00	
Neutrophils Count $\times 10^3$	> 7.00	0.67	0.410
	1.50–7.00	1.03	0.926
	< 1.50	1.00	
Lymphocytes Count $\times 10^3$	> 4.00	1.58	0.392
	1.20–4.00	2.07	0.205
	< 1.20	1.00	
Monocytes Count $\times 10^3$	> 1.00	1.01	0.975
	0.20–1.00	1.06	0.869
	< 0.20	1.00	

(*Continued*)

https://doi.org/10.2147/JBM.S558610

Table 7 (Continued).

Variable	Variable Category	Odds Ratio	p-value
Eosinophils Count $\times 10^3$	> 4.00	1.00	
	0.02–4.00	0.87	0.859
	< 0.02	1.00	
Basophils Count $\times 10^3$	> 0.10	0.47	0.057
	0.00–0.10	1.00	
Platelets (μL)	> 450	1.00	
	150 - 450	0.39	0.002
	< 150	1.00	
Mean platelet volume (fL)	9.00–13.00	1.30	0.729
	< 9.00	1.00	
Red blood cell count $\times 10^6$	> 6.00	1.00	
	4.10–6.00	0.84	0.724
	< 4.10	1.00	
Haemoglobin level (g/dL)	11.00–17.50	0.63	0.416
	< 11.00	1.00	
Haematocrit (%)	> 45.00	0.76	0.803
	35.00–45.00	1.11	0.866
	< 35.00	1.00	
Mean corpuscular volume (fL)	> 100	1.05	0.931
	80.00–100.00	0.93	0.865
	< 80.00	1.00	
Mean corpuscular haemoglobin (pg)	> 32.00	0.85	0.690
	27.00–32.00	0.90	0.768
	< 27.00	1.00	
Mean corpuscular haemoglobin concentration (g/dL)	> 35.00	2.46	0.388
	33.00–35.00	0.92	0.846
	< 33.00	1.00	
Red cell distribution width (%)	> 17.00	1.11	0.837
	12.00–17.00	1.00	
Age	Under 5 years	1.00	0.004
	5 - 10 years	0.07	0.362
	> 10 years	0.20	0.000
Sex	Female	1.00	
	Male	1.17	0.584

Table 8 Multivariable Analysis of Haematological for Participants on Hydroxyurea

Variable Categories		Odds Ratio	p-value
Platelets (μL)	> 450	1.00	
	150 - 450	0.35	0.001
	< 150	1.00	
Age	Under 5 years	1.00	
	5 - 10 years	0.59	0.195
	> 10 years	0.18	0.000

Table 9 Univariable Analysis of Haematological Profiles for Participants Below Age 5 years

Variable	Variable Category	Odds Ratio	p-value
White Blood Cell Count $\times 10^3$	> 11.00	1.068	0.86
	4.00–11.00	1.121	0.76
	< 4.00	1	
Neutrophils Count $\times 10^3$	> 7.00	1.106	0.777
	1.50–7.00	1.281	0.317
	< 1.50	1	
Lymphocytes Count $\times 10^3$	> 4.00	1.63	0.244
	1.20–4.00	1.344	0.498
	< 1.20	1	
Monocytes Count $\times 10^3$	> 1.00	1.271	0.39
	0.20–1.00	1.407	0.168
	< 0.20	1	
Eosinophils Count $\times 10^3$	> 4.00	1	
	0.02–4.00	4.725	0.007
	< 0.02	1	
Basophils Count $\times 10^3$	> 0.10	1.349	0.187
	0.00–0.10	1	
Platelets (μL)	> 450	1.475	0.532
	150 - 450	0.902	0.868
	< 150	1	
Mean platelet volume (fL)	9.00–13.00	0.512	0.16
	< 9.00	1	

(*Continued*)

Table 9 (Continued).

Variable	Variable Category	Odds Ratio	p-value
Red blood cell count $\times 10^6$	> 6.00	1	
	4.10–6.00	0.968	0.943
	< 4.10	1	
Haemoglobin level (g/dL)	11.00–17.50	0.968	0.943
	< 11.00	1	
Haematocrit (%)	> 45.00	3.5619	0.248
	35.00–45.00	0.5597	0.163
	< 35.00	1	
Mean corpuscular volume (fL)	> 100	2.3506	0.014
	80.00–100.00	1.291	0.388
	< 80.00	1	
Mean corpuscular haemoglobin (pg)	> 32.00	3.076	0
	27.00–32.00	1.683	0.025
	< 27.00	1	
Mean corpuscular haemoglobin concentration (g/dL)	> 35.00	1.7818	0.288
	33.00–35.00	0.9898	0.972
	< 33.00	1	
Red cell distribution width (%)	> 17.00	1.709	0.131
	12.00–17.00	1	
Sex	Female	1	
	Male	1.01	0.958
Hydroxyurea	Yes	0.379	0.004
	No	1	

Table 10 Multivariable Analysis of Haematological Profiles for Participants Below Age 5 years in Acholi Sub-Region of Northern Uganda

Variable		Odds Ratio	p-value
Hydroxurea use	Yes	0.37	0.004
Eosinophils Count $\times 10^3$	0.02–4.00	4.23	0.014
Mean platelet volume	9 −13	0.43	0.084
Mean corpuscular haemoglobin	27 - 32	1.62	0.043
	>32	2.99	0.000

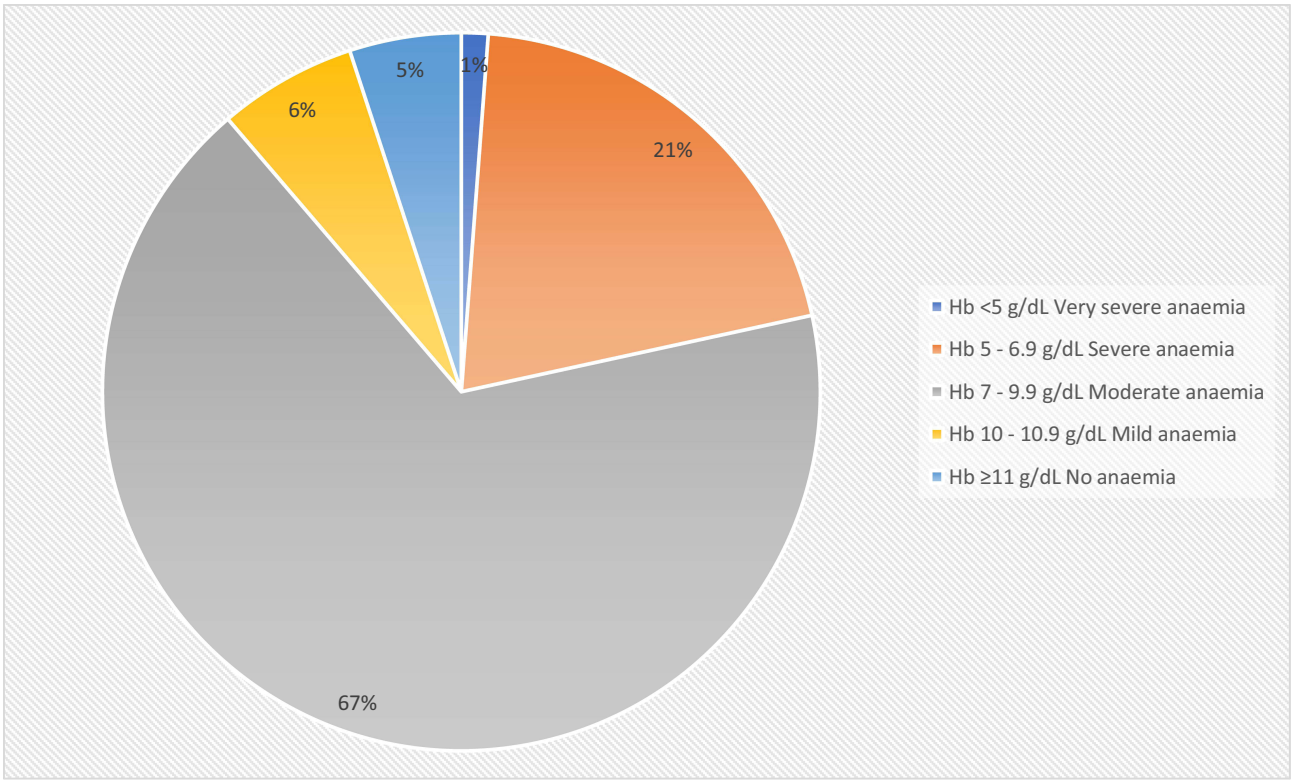

Figure 1 Prevalence of anaemia among patients of sickle cell disease in the Acholi sub-region of northern Uganda.

Prevalence of Severe Anaemia

Over 80% of patients with SCD had moderate-to-severe anaemia. As outlined in the table below, barely 5% of the patients had haemoglobin levels of at least 11.0g/dL. The grade of Anaemia was divided based on the Uganda Clinical guidelines (No anaemia ≥ 11.0g/dL; Mild Anaemia 10.0–10.9g/dL; Moderate Anaemia 7.0–9.9g/dL; Severe Anaemia 5.0–6.9g/dL and Very severe <5.0 g/dL)[19] as shown in Figure 1.

Discussion

In this research, the mean age of patients with SCD was 7 years, the median was 5, and the range was one to 28. Over 48% of the patients had leucocytosis and thrombocytosis, and 63% had lymphocytosis. The Shapiro test revealed that the cell counts were not normally distributed. Over 80% had moderate-to-severe anaemia, and at least 90% had a high red cell distribution width and low haematocrit. Hydroxyurea use was associated with a normal platelet count.

In central Uganda, the median (IQR) age of SCD patients was 6 (3–11) years, with the majority having a positive family history of SCD.[20] This is similar to what we have seen in the Acholi sub-region.

The high prevalence of anaemia increases the demand for blood products,[19,21] poor growth,[21] chronic fatigue,[21] organic malfunction or damage[21] and increased frequency of infections.[22] This is even worse for participants not on hydroxyurea.[23] That increases the risk of mortality in patients with SCD.[22,24]

Over 48% of the patients had leucocytosis and thrombocytosis. Studies done in Ghana,[18] Nigeria,[25] and Kenya[16] revealed the white blood cell and platelet counts were significantly higher in patients with SCD compared with their healthy counterparts ($P<0.05$). They also found general erythropenia among SCD patients compared to controls,[16,18] similar to what we uncovered.

Leucocytosis is caused by endothelial injury from sickled red blood cells, resulting into inflammation.[23] Up to 65% of patients with SCD may also have viral infections, especially parvovirus.[26] Parvovirus has been associated with leucocytosis and shorter lifespan of the red blood cells, leading to erythropenia.[26–28] This may explain why the total

https://doi.org/10.2147/JBM.S558610

white blood cell, lymphocyte, monocyte, eosinophil, and basophil counts had positively skewed distributions with a low erythrocyte (red blood cell) count. Leucocytes attach to erythrocytes and vascular endothelium to cause vaso-occlusion.[23] An elevated leukocyte count is responsible for clinical manifestations in SCD such as clinical stroke, acute chest syndrome, end-organ damage, and infarction pain.[23]

According to the 2024 national census of Uganda,[29] Acholi sub-region has over two million people, so with a prevalence of 1.3% HbSS,[6] we expect about 26,000 people to be living with SCD in this region. Optimal therapy for sickle cell disease (SCD) is critical in reducing the episodes of complications, which in turn minimises hospitalisation and early mortality. All SCD patients are given folic acid tablets to take for life, while only a few are eligible for hydroxyurea, which is only available at referral hospitals.[19,30,31] Like other African countries, the level of utilisation of hydroxyurea in the treatment of SCD among care providers is sub-optimal, with the lack of expertise in its use and high cost identified as the most prominent barrier.[20,32]

As patients with sickle-cell disease age, they are at risk of vasculopathy characterised by systemic and pulmonary hypertension, endothelial dysfunction, and proliferative changes in the intima and smooth muscle of their blood vessels.[1] Oxidative stress plays a significant role in the pathogenesis of sickle cell disease.[33] These may partly explain the thrombocytosis and why we could not get patients beyond the age of 28 in the sickle cell clinics during the study period.

The participants on hydroxyurea in this study were more likely to have a normal platelet count. This is probably the reliable marker for steady-state disease[34,35] and a good prognosis for the quality of life.[34]

Strengths and Limitations

This was a cross-sectional study of patients with sickle cell disease only, and no controls were recruited for comparison. Blood cultures, gene typing and comparing with controls, liver and renal function tests were not done due to resource limitations. Results from the two hospitals may not reflect the general situation within the whole Acholi subregion. Perhaps, many patients with SCD not yet initiated on hydroxyurea did not see the reason to travel long distances for regular checkups at the hospital. However, this is a baseline on which many research projects may be developed.

Conclusion

The patients with SCD had leucocytosis, thrombocytosis, and erythropenia. Over 80% of them had moderate-to-severe anaemia despite being on folic acid for life and hydroxyurea. That may signify the increase in haemolytic activities with their blood vessels, probably due to the sickled red blood cells. Use of hydroxyurea was associated with a normal platelet count.

Recommendation

The healthcare providers should enroll all patients with sickle cell disease on hydroxyurea. For researchers, the sickle cell disease genotype, viral infections screening, and blood cultures should be performed to rule out infections that could cause more red cell haemolysis. Policymakers should endeavour to bring services closer to the people who need them the most.

Data Sharing Statement

Data will be available from the faculty of science, the directorate of research and graduate training of Gulu University, and the principal investigator, who is also the corresponding author. Request for data should be made in writing and directed to the Directorate of Research and Graduate Training.

Ethical Approval and Consent to Participate

The Gulu University Research and Ethics Committee and the Uganda National Council for Science and Technology approved the study, and written informed consent was obtained from every participant. The research was conducted according to the Declaration of Helsinki.

Consent for Publication

All authors have agreed to publish this work.

Acknowledgment

I acknowledge the research assistants and participants who made this work possible.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

There is no funding to report.

Disclosure

The authors report no conflicts of interest in this work.

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