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Research Article

Knowledge, attitude, and practice of Sudanese clinicians regarding leukopenia and arthritis as early indicators for differentiating systemic lupus erythematosus

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Background: Systemic lupus erythematosus (SLE) is a chronic autoimmune disorder that shows variable early symptoms. Leukopenia and non-erosive arthritis are two important early features that can guide timely diagnosis, but there are often under-recognized, particularly in resource-limited countries such as Sudan. Evaluating clinicians' knowledge and practices is vital for improving early detection**.** To assess the knowledge, attitudes, and clinical practices of Sudanese clinicians regarding leukopenia and non-erosive arthritis as early signs of systemic lupus erythematosus (SLE), aiming to support timely diagnosis and improved patient management.

Methods: A descriptive cross-sectional study was conducted among 348 Sudanese clinicians. Participants completed a structured self-administered questionnaire assessing knowledge, attitudes, and practices related to early SLE recognition, alongside the demographic and professional characteristics. Data were analyzed using Chi-square, t-tests, ANOVA, and Pearson's correlation.

Results: Among 348 clinicians (53% female; mean age 30.2 years), only 7% were rheumatologists and 33% had formal rheumatology and autoimmune training. Overall knowledge of early SLE features was moderate (mean 4.1/7), with higher scores in rheumatologists ($p < 0.021$) and trained clinicians ($p < 0.036$). Attitudes were positive (mean 21.5/25), especially with training ($p < 0.038$). In practice, 70% ordered Complete blood count (CBC) and 60% ordered Antinuclear antibody/double-stranded DNA (ANA/dsDNA) or referred appropriately; rates were higher among specialists ($p < 0.017$) and trained clinicians ($p < 0.028$). Main barriers were overlapping symptoms (33%) and limited test access (30%). Knowledge correlated with attitude ($p < 0.020$) and practice ($p < 0.024$) attitude correlated with practice ($p < 0.011$).

Conclusion: Sudanese clinicians are aware of early SLE features, but confirmatory diagnostic steps remain inconsistent. Expanding training and improving access to specialized tests could enhance early diagnosis and patient outcomes.

Keywords: *systemic lupus erythematosus, leukopenia, non-erosive arthritis, early diagnosis, clinical knowledge*

Introduction

Systemic lupus erythematosus (SLE) is a chronic multisystem autoimmune disease characterized by a heterogeneous clinical presentation and unpredictable disease course. Early clinical manifestations are often nonspecific, which can

complicate timely diagnosis, especially in low-resource settings such as Sudan (Fanouriakis et al., 2024). Among these early features, leukopenia and non-erosive arthritis are frequently observed and may serve as important indicators for suspecting SLE; however, they are often overlooked or misattributed to alternative conditions, delaying appropriate investigation and management (Durcan et al., 2019). The challenges of early SLE diagnosis are magnified in sub-Saharan Africa, where rheumatology services are scarce, access to specialized immunological testing is limited, and structured postgraduate training in autoimmune diseases is uncommon (Adelowo et al., 2021; Paruk et al., 2025). This limited capacity has been shown to contribute to diagnostic delays and suboptimal patient outcomes across the region, as documented in clinician-based surveys from Nigeria, Uganda, Ghana, and Kenya (Lam et al., 2023; Essouma & Noubiap, 2024). Evidence from several African studies indicates that insufficient clinician knowledge and low exposure to rheumatology during medical education correlate with reduced diagnostic confidence in autoimmune diseases (Gergianaki & Bertsias, 2018; Tessema et al., 2021). Improving the awareness and diagnostic practices of frontline clinicians particularly regarding early hematologic and musculoskeletal signs has the potential to shorten the diagnostic interval, facilitate timely interventions, and improve prognosis for patients with SLE (Adelowo et al., 2021; Dey et al., 2024). Despite these challenges, no comprehensive national-level analysis has been conducted in Sudan to evaluate clinicians' knowledge, attitudes, and practices (KAP) toward early SLE diagnosis. This study aims to address this gap by assessing these parameters, with a specific focus on leukopenia and non-erosive arthritis as early disease indicators, and to highlight areas that require targeted educational and systemic interventions (Adelowo et al., 2021).

Materials and Methods

A descriptive cross-sectional study was conducted between May and August 2025 involving 348 clinicians from hospitals and primary care centers in Sudan, including general practitioners, rheumatologists, internists, pediatricians, and others. Medical students and non-clinical administrators were excluded. Participants were recruited from a purposively selected range of hospitals and primary care centers across urban and rural regions of Sudan to reflect the diverse clinical workforce. The sample included clinicians from general practice, pediatrics, internal medicine, and rheumatology specialties, mirroring the national distribution of healthcare providers. Sampling aimed to ensure inclusion of both trained and untrained clinicians to capture the current state of knowledge and practice.
Data collection used a structured, self-administered questionnaire developed via literature review and input from Sudanese rheumatology and hematology experts.

The instrument was pilot tested among 20 clinicians, refined based on feedback for clarity and relevance. Content validity was reviewed by experts. Internal reliability of the knowledge and practice sections was verified (Cronbach's Alpha: knowledge = 0.78; attitude = 0.81; practice = 0.75). Items covered demographics, training, and KAP for early SLE diagnosis. Seven knowledge items assessed recognition of early features (leukopenia, non-erosive arthritis); attitudes used a five-point Likert scale. Data were analyzed using SPSS (v28) for descriptive statistics (means, SD, proportions), group comparisons (Chi-square, t-tests, ANOVA), and correlations (Pearson). P-values reported consistently in text and tables; significance set at $p< 0.05$.

The required sample size for this study was calculated using the standard formula for estimating proportions: Sample Size Calculation

$$n = \frac{Z^2 \times p \times (1 - p)}{e^2}$$

n = required sample size.
Z = Z-score (standard normal deviate corresponding to the desired confidence level, e.g., 1.96 for 95%).
P = estimated proportion of the population (since no prior data were available, 0.5 was used to maximize the sample size)
e = margin of error (precision) 0.05 (for 5%).

$$n = \frac{1.96 \times 1.96 \times 0.5 \times (1 - 0.5)}{0.05 \times 0.05}$$

$$n = \frac{3.8416 \times 0.25}{0.0025} = 384.16$$

Thus, the maximum required sample size was 384 participants. To enhance the reliability and statistical power of the study, a final sample of 348 valid responses was included in the analysis.

Results

Demographics

Of 348 clinicians, 53% were female. Mean age: 30.2 ± 5.5 years (Table 1). The sample included general practitioners (43%), internists (10%), pediatricians (10%), rheumatologists (7%), and others (30%).

Training and Experience

Only 33% had formal training in rheumatology/autoimmune diseases and most had <5 years practice.

Table 1. Demographic and Professional Characteristics of Participants (n = 384)

Variable	Category	N	%
Age (mean ± SD)		30.2 ± 5.5	
Gender	**Female**	185	53
	Male	163	47
Specialty	**General Practitioner**	150	43
	Rheumatology	23	7
	Internal Medicine	35	10
	Pediatrics	35	10
	Others	105	30
Formal Training	**Yes**	115	33
	No	233	67
Experience	**< 1 year**	73	21
	1–5 years	178	51
	>5 years	93	28

Knowledge

Mean knowledge score (out of 7): 4.1 (SD 1.2), moderate overall.
40% achieved high knowledge (≥5/7 correct); 60% correctly identified both leukopenia and arthritis as early signs.
Rheumatologists and formally trained clinicians had significantly higher scores ($p < 0.021$, $p < 0.036$) respectively (Table 2). No significant difference was found by gender ($p > 0.764$) or experience ($p > 0.582$).

Table 2. Knowledge Indicators

Variable/Parameter	Result	N (%) / Mean ± SD	Statistical Test / p-value
Mean Knowledge score (out of 7)	Moderate	4.1 (SD = 1.2)	–
High knowledge (≥5/7 correct)	40%	139/348	–
Correct identification of leukopenia + arthritis as early SLE signs	60%	209/348	–
Knowledge by specialty (rheumatology vs. others)	Highest in rheumatologists	–	ANOVA, **p < 0.021**
Knowledge by formal training	Higher with formal autoimmune/rheum training	–	Chi-square, **p < 0.036**
Knowledge by years of experience	No significant difference	–	ANOVA, p >0.582
Knowledge by gender	No significant difference	–	t test p > 0.764

Attitude

Mean attitude score (out of 25): 21.5 (SD 3.1), generally positive (Table 3).
90% agreed leukopenia is an important early sign; 80% supported routine screening in arthritis cases.

Formally trained participants had higher attitude scores ($p < 0.038$); no significant difference by gender or experience. All scale reliabilities were acceptable (Cronbach's Alpha: 0.81).

Table 3. Attitude Indicators

Variable/Parameter	Result	n (%) / Mean ± SD	Statistical Test / p-value
Mean attitude score (out of 25)	Positive	21.5 ± 3.1	-
Leukopenia is an important early SLE sign (agree/strongly agree)	90%	314/348	-
Support routine SLE screening in arthritis cases	80%	278/348	-
SLE arthritis is easily distinguishable	43%	150/348	-
Scale internal reliability	Good	Cronbach's alpha = 0.81	-
Attitude by formal training	Higher with formal training	-	t-test **p < 0.038**

Practice

70% routinely ordered CBC for joint complaints, 60% ordered immunologic tests (ANA, dsDNA) or appropriate referral (Table 4).
Specialists and trained clinicians practiced better ($p < 0.017$, $p < 0.028$).
Barriers: 33% cited overlapping symptoms, 30% limited access to tests.
33% admitted missing/delaying SLE diagnosis; only 23% "always" considered SLE when relevant.

Table 4. Practice Indicators

Variable/Parameter	Result	N	Statistical Test / p-value
Routinely order CBC for joint complaints	70%	244/348	-
Routinely order ANA/dsDNA or refer to rheumatology	60%	209/348	-
Ever missed/delayed an SLE diagnosis	33%	115/348	-
Main diagnostic challenges/ Overlapping symptoms	33%	115/348	-
Main diagnostic challenges/ limited test access	30%	104/348	-
Frequency of considering SLE in relevant cases (Always/Often/Sometimes/Rarely/Never)	23% / 30% / 27% / 13% / 7%	80/104/94/45/25	-
Practice by specialization Rheumatologists	Significantly higher with practice	-	Chi-square **p < 0.017**
Practice by formal training	Significantly higher with practice	-	Chi-square **p < 0.028**
Practice by years' experience	No significance	-	ANOVA $p > 0.064$

Correlations

Knowledge correlated with attitude ($r = 0.42$, $p < 0.020$), and with practice ($r = 0.39$, $p < 0.024$); attitude and practice also correlated ($r = 0.44$, $p < 0.011$) (Table 5).

Table 5. Correlation between Knowledge, Attitude, and Practice

Variable/Parameter	Result	R	p-value
Knowledge ↔ attitude	Significant moderate positive correlation	r = 0.42	**0.020**
Knowledge ↔ Practice	Significant moderate positive correlation	r = 0.39	**0.024**
Attitude ↔ Practice	Significant moderate positive correlation	r = 0.44	**0.011**

Discussion

Despite advances in systemic lupus erythematosus (SLE) diagnosis, early recognition by non-specialists remains challenging, often leading to delay and missed therapeutic windows (Kaul et al., 2016). This study evaluated Sudanese clinicians' knowledge, attitudes, and practices (KAP) regarding early SLE features, focusing on leukopenia and arthritis, two commonly under-recognized signs in low-resource settings. The sample included 348 clinicians across specialties and sectors, reflecting Sudan's clinical workforce. Demographically, participants were young (mean 30.2 ± 5.5 years) and gender-balanced (53% female), resembling clinician cohorts in other low- and middle-income countries (Adelowo et al., 2021). General practitioners formed the largest group (43%), whereas rheumatologists were scarce (7%). Only one-third reported formal training in rheumatology or autoimmune disease, a shortage also noted in Ethiopia, Ghana, and across sub-Saharan Africa (Dey et al., 2024). Overall knowledge was moderate (mean 4.1/7), with only 40% demonstrating high knowledge and 60% identifying both leukopenia and arthritis as early features. These results are consistent with clinician-based studies in Nigeria and South Africa, where early SLE recognition was similarly low-to-moderate (Odunlami et al., 2024). Specialty and training were the strongest predictors of better knowledge, with significantly higher scores among rheumatologists ($p = 0.021$) and trained clinicians ($p = 0.036$), echoing international evidence that specialty education, rather than clinical experience, drives diagnostic accuracy (Aringer et al., 2019). Neither gender nor years of practice correlated with higher scores ($p > 0.764$; $p > 0.582$), underscoring that exposure alone does not improve recognition of complex autoimmune disease (Paruk et al., 2025). One-third of respondents admitted to missed or delayed diagnoses, comparable to global reports (Ruiz-Irastorza et al., 2009). Diagnostic difficulty is expected given the nonspecific nature of common presenting symptoms. Joint pain affects up to 90% of early SLE cases (Fava & Petri, 2019), while leukopenia, although frequent, is nonspecific and often overlooked (Doria et al., 2010). Attitudes toward early diagnosis were more favorable. The mean score was high (21.5/25; Cronbach's Alpha = 0.81). Most clinicians (90%) recognized leukopenia as important, and 80% supported routine screening in arthritis patients. These results outperform findings from Ghana and Uganda, where exposure to SLE was lower (Essouma & Noubiap, 2024). However, fewer than half (43%) believed lupus arthritis is readily distinguishable in early disease, reflecting the challenge of differentiating it from viral arthritis or early rheumatoid arthritis (Mok & Lau, 2003). In Africa, endemic infectious diseases like malaria and tuberculosis further complicate the diagnostic picture (Alene et al., 2022). Formal training correlated with more favorable attitudes ($p = 0.038$), consistent with international data linking education to diagnostic confidence (Adelowo et al., 2021). Gender and years of practice showed no effect (Adelowo et al., 2021). Practical measures lagged behind attitudes. About 70% routinely ordered CBCs for joint complaints, yet only 60% ordered ANA/dsDNA or referred appropriately. Similar gaps have been reported in Nigeria and Kenya, where limited test availability and specialist shortages impede confirmation of suspected cases (Tessema et al., 2021). Barriers cited included overlapping symptomatology (33%) and poor access to tests (30%), factors echoed in other African studies (Narain et al., 2004). Moreover, only 23% "always" considered SLE in relevant cases, suggesting inconsistent suspicion. Diagnostic practices were significantly better among rheumatologists ($p = 0.017$) and clinicians with formal training ($p = 0.028$). Prior studies confirm that specialists have greater accuracy in identifying SLE than generalists (O'Sullivan & Schofield, 2018). Structured education has repeatedly been shown to improve competence and recognition in autoimmune disease, with CME and focused training yielding measurable gains (Norman et al., 2017). The relationship between knowledge, attitudes, and practices in this study reinforces theoretical frameworks of clinical reasoning. Knowledge correlated positively with attitude ($r = 0.42$, $p < 0.020$), reflecting findings that deeper understanding fosters clinician readiness (Fava & Petri, 2019). Knowledge also correlated with diagnostic practice ($r = 0.39$, $p < 0.024$), paralleling reports that formal knowledge strengthens pattern recognition and efficiency in multisystem disease diagnosis (Palazzo et al., 2022). Similarly, positive attitudes were linked with better practices ($r = 0.44$, $p < 0.011$), in line with evidence that clinician decision-making is shaped not only by knowledge but also by cognitive orientation and perceived urgency (Hahn et al., 2012).

This is the first national level study assessing Sudanese clinicians' knowledge, attitudes, and practices specifically focused on early hematologic and musculoskeletal indicators of SLE. The findings offer valuable insights into gaps that impede timely diagnosis in resource limited contexts and align with broader challenges observed across sub–Saharan Africa and other low middle-income countries. Addressing these gaps through structured education, improved test availability, and effective referral pathways is crucial for reducing diagnostic delays and improving lupus outcomes regionally and globally. In summary, Sudanese clinicians demonstrate moderate knowledge and favorable attitudes toward early SLE features, but practice remains inconsistent, especially regarding confirmatory testing and referrals. Diagnostic accuracy is strongly associated with specialty and formal training, highlighting the need for structured rheumatology education rather than reliance on clinical experience alone. Strengthening postgraduate training, alongside improved access to serological tests and referral systems, can narrow the gap between suspicion and timely confirmation. Addressing these educational and systemic limitations is critical for reducing diagnostic delay and improving outcomes for SLE patients in resource-limited contexts.

Conclusion

In conclusion, formal autoimmune training significantly improves clinicians' knowledge and early diagnosis of SLE, whereas experience and gender do not. Despite positive attitudes, underutilization of immunologic testing and limited confidence in recognizing clinical features, combined with restricted laboratory access, contribute to underdiagnosis and delayed referrals. These findings emphasize the need for structured CME programs, enhanced laboratory capacity, and strengthened referral systems to support timely and accurate SLE diagnosis.

Author contributions

Each author made a significant intellectual contribution, reviewed and approved the final manuscript version, and consented to take responsibility for all elements of the work.

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AI usage declaration

The authors have declared that no AI and associated tools were used to create scientific contents and interpretation of the results in this manuscript. But authors used Grammar or style correction tools such as Grammarly, ChatGPT and QuillBot were used to improve the language and readability of the manuscript.

Conflict of interest

The author declares no conflict of interest. The manuscript has not been submitted for publication in other journal.

Ethics approval

Ethical approved was obtained from the National Health Research Ethics Committee (NHREC).

Consent to publish

All participants provided written informed consent, and the study followed the Declaration of Helsinki ethical guidelines.

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