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Original Article

Knowledge, Attitudes, Perceived Stigma, and Social Determinants of Sickle Cell Disease Among Medical Students in Cameroon: A Mixed-Methods Study

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Abstract

Introduction: Sickle cell disease (SCD) remains a major public health challenge in sub-Saharan Africa. Medical students play a key role in its prevention, diagnosis, management, and advocacy, yet their preparedness in Cameroon remains poorly understood.

Methods: We conducted a cross-sectional mixed-methods study among medical students across Cameroon using an anonymous questionnaire to assess knowledge, attitudes, stigma, social determinants, and advocacy engagement. Quantitative data were analyzed using descriptive, bivariate, and multivariable methods, while qualitative responses were thematically analyzed.

Results: Among 333 participants, foundational knowledge was high: 99.7% identified SCD as genetic, and 95.2% recognized hemoglobin electrophoresis as diagnostic. However, gaps existed: only 58.0% identified hydroxyurea, and 22.5% understood curative options. Attitudes were positive, but perceptions of stigma persisted. While 82.6% were willing to engage in advocacy, only 36.3% had participated. Year of study predicted knowledge. Qualitative findings highlighted stigma, economic hardship, and training gaps.

Conclusion: Medical students demonstrate strong basic knowledge, but gaps in management and continued exposure to stigma remain. Curriculum strengthening is needed.

Keywords: Anemia, Sickle cell, Students, Medical, Health knowledge, Attitudes, Practice, Social stigma, Social determinants of health

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Introduction

Sickle cell disease (SCD) is a severe inherited hemoglobin disorder caused by a mutation in the β-globin gene, producing abnormal hemoglobin S and sickle-shaped red blood cells. This causes chronic hemolytic anemia, recurrent vaso-occlusive crises, infection susceptibility, and progressive multi-organ damage, contributing to substantial morbidity and premature mortality. SCD is among the most prevalent monogenic diseases globally: more than 500,000 infants are born with the condition annually, nearly 80% of them in sub-Saharan Africa (SSA).[1,2]

Inadequate newborn screening, restricted access to disease-modifying medicines, workforce shortages, and high out-of-pocket costs compound this burden in SSA, producing poorer outcomes and disproportionately high childhood mortality relative to high-income settings. The World Health Organization has accordingly emphasized integrating SCD prevention, diagnosis, and care into primary healthcare systems in high-burden countries.[3,4]

Cameroon bears a substantial share of this burden: the sickle cell trait is present in about 20% of the population, and an estimated 7,000 newborns are affected each year.[5] Despite this prevalence, national SCD control plans remain limited, and delayed diagnosis, low public awareness, uneven access to hydroxyurea, weak social support, and stigma rooted in beliefs about inheritance continue to

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hinder care, as in many African contexts.[5,6]

Medical students are a key demographic in addressing these gaps: as future physicians, they will drive counseling, early diagnosis, clinical management, advocacy, and public education, which requires sound understanding of SCD genetics, comorbidities, and evidence-based therapy. However, studies from African and other low- and middle-income settings consistently identify gaps in students' understanding of long-term care, disease-modifying treatments, and preventive measures such as genetic counseling and newborn screening, and show that awareness of SCD does not always translate into accurate comprehension or favorable clinical attitudes.[7–10]

Beyond knowledge, stigma and attitudes are increasingly recognized as important influences on patient experience and care quality among healthcare trainees. People with SCD can face social exclusion, psychological distress, and delayed care-seeking driven by false beliefs that they exaggerate pain, are ill by choice, or are financially burdensome; healthcare professionals may unintentionally reinforce these views, particularly where resources are limited. Understanding how medical students perceive stigma and social determinants is therefore essential to developing educational interventions that support patient-centered, compassionate care.[11,12]

Despite this, empirical evidence examining Cameroonian medical students' knowledge of SCD alongside their attitudes, perceived stigma, and understanding of its social determinants remains limited; existing research in the country has focused mainly on epidemiology, policy gaps, and clinical barriers, with little attention to the perspectives of future healthcare providers, despite the formative role medical education plays in shaping both clinical competence and professional values.

Objectives of the Study

To address this gap, this study aimed to assess Cameroonian medical students' knowledge of SCD, attitudes toward SCD care, perceived stigma, and perceptions of key social determinants affecting people living with SCD. Specifically, the study sought to:

1. Evaluate the level of knowledge of SCD among medical students, including understanding of etiology, inheritance, complications, and treatment.
2. Assess attitudes toward caring for individuals with SCD, including confidence and willingness to provide care.
3. Examine perceptions of stigma related to SCD within healthcare and society.
4. Identify social and structural factors perceived by medical students as most strongly affecting the quality of life of people living with SCD.
5. Explore associations between knowledge, attitudes, stigma, and selected sociodemographic and training-related factors.

These findings are intended to inform medical curriculum development and targeted educational interventions on SCD in Cameroon and comparable high-burden settings.

Methods

Study Design and Setting

This study used a cross-sectional, questionnaire-based survey to evaluate medical students' knowledge, attitudes, and perceptions of sickle cell disease (SCD) and its social determinants in Cameroon. To ensure geographic and institutional representation, data were collected from September to December 2025 among students from various accredited medical schools.

The recruitment process utilized stratified convenience and snowball sampling through student associations and social media platforms (WhatsApp, LinkedIn, Facebook, and Telegram); study invitations were distributed across participating universities and years of study to avoid over-representing any single institution or training level, and all participants gave informed consent after a briefing on the study's objectives, voluntary nature, and anonymity. However, because recruitment ultimately relied on convenience and snowball referral rather than random sampling within strata, enrollment quotas per stratum were not fixed in advance, and the achieved sample sizes per university and year (Table 1) reflect actual participation rather than pre-specified targets. A complete sampling frame was not available, so a formal response rate could not be calculated, and students without regular access to the social media platforms used for recruitment may be underrepresented; these constraints are discussed further in the Strengths and Limitations section.

Study Population and Eligibility Criteria

Eligible participants were undergraduate medical students (preclinical and clinical levels) enrolled in recognized medical schools in Cameroon at the time of data collection. Students from all years of study were eligible to participate. Participation was voluntary, and no incentives were offered.

Students who did not provide informed consent or who submitted incomplete questionnaires for key outcome variables were excluded from the relevant analyses.

Data Collection Instrument

Data were collected using a structured, self-administered questionnaire developed from existing literature on SCD education, stigma, and social determinants of health, and adapted to the Cameroonian context. A formal pilot study with systematic pre-testing of item wording in a separate sample was not conducted prior to deployment; this is acknowledged as a limitation, though the psychometric properties of the three composite scales were subsequently examined post hoc using the full analytic dataset (N = 333), including item-total correlations and single-factor exploratory factor analysis with Kaiser-Meyer-Olkin and Bartlett's tests of sampling adequacy (reported in Results: Scale reliability and structure). The final questionnaire, administered electronically, comprised the following sections:

Sociodemographic Characteristics

Information collected included age, gender, year of study,

Table 1. Sociodemographic characteristics (N = 333)

Variable	Category	N	%
Gender	Female	204	61.3
	Male	128	38.4
	Prefer not to say	1	0.3
Year of study	1st	21	6.31
	2nd	69	20.7
	3rd	75	22.5
	4th	43	12.9
	5th	34	10.2
	6th	68	20.4
	7th	23	6.91
University	CATUC Kumbo	10	3.0
	FHS Bamenda	15	4.5
	FHS Buea	90	27.0
	FMBS Garoua	38	11.4
	FMBS Yaoundé	17	5.11
	FMPS Douala	83	24.9
	FMPS Dschang	31	9.31
	FMPSP Sangmelima	9	2.7
	ISSS UdM Bangangté	27	8.11
	ISTM Yaoundé	13	3.9
Region of origin	Adamawa	7	2.1
	Centre	34	10.2
	East	4	1.2
	Far North	18	5.41
	Littoral	38	11.4
	North	13	3.9
	Northwest	50	15.0
	South	11	3.3
	Southwest	64	19.2
	West	94	28.2
Formal training on SCD	No	114	34.2
	Yes	219	65.8
Personally know someone living with SCD	No	163	49.0
	Yes	170	51.0

university/institution, region of origin, history of formal training on SCD, and whether the respondent personally knew someone living with SCD.

Knowledge of Sickle Cell Disease

Knowledge of SCD was assessed using seven items covering: genetic cause of SCD, inheritance patterns, common complications, infection susceptibility, importance of newborn screening, disease-modifying therapy (hydroxyurea), and curability of SCD.

The composite knowledge score summed seven multiple-choice items (1 point per correct response; range 0-7), with higher scores indicating greater knowledge. All items were weighted equally regardless of clinical complexity, so the score does not distinguish foundational concepts (e.g., genetic cause, inheritance pattern) from more advanced, clinically applied concepts (e.g., disease-modifying therapy, curability); this is acknowledged as a limitation (see Strengths and limitations).

Perceived Stigma and Attitudes Toward SCD Care

Perceptions of stigma and attitudes were assessed using Likert-scale items rated on a five-point scale ranging from *Strongly Disagree (1)* to *Strongly Agree (5)*.

For quantitative analysis, two composite scales were constructed:

- Perceived stigma scale, derived from selected items assessing societal blame, cultural beliefs, employment discrimination, healthcare provider attitudes, and avoidance of patients with SCD.
- Attitude toward SCD care scale, derived from items assessing confidence in addressing social issues, comfort in treating individuals with SCD, and beliefs about quality of life and curriculum coverage.

Item selection emphasized conceptual coherence and parsimony. Higher scores indicated greater perceived stigma or more positive attitudes, respectively.

Perceived Social Determinants of Health

Perceptions of social determinants were assessed in two ways:

1. Likert-scale items measuring agreement with statements related to economic hardship, educational exclusion, public awareness, social isolation, and community-level factors.
2. A social determinants checklist, where respondents were asked to select up to three factors they believed most affected the quality of life of people living with SCD in Cameroon (e.g., poverty, stigma, cost of treatment, lack of newborn screening, cultural beliefs).

Checklist items were analyzed descriptively, with frequencies and percentages.

Open-Ended Qualitative Responses

The questionnaire also included open-ended free-text questions inviting participants to describe, in their own words: (i) the social and economic challenges faced by people with SCD in Cameroon, (ii) suggested curriculum changes, and (iii) how their training had shaped their perceptions of SCD. Responses were analyzed using a structured content/thematic approach: the research team read all responses, generated descriptive codes, and iteratively grouped these into broader themes through discussion and consensus until no new themes emerged. Because responses were brief, single-occasion survey items rather than in-depth interview data, the traditional concept of thematic saturation does not directly apply as it would for interview-based qualitative research; all available responses were coded, and findings are summarized narratively rather than as attributed verbatim quotations, to protect respondent anonymity given the small, identifiable nature of some institutional sub-groups.

Data Management and Statistical Analysis

Data were exported and analyzed using R version

4.3.2. Descriptive statistics summarized respondent characteristics. Internal consistency of multi-item scales was assessed with Cronbach's alpha, where values ≥ 0.60 were deemed acceptable due to the exploratory nature of the study. Corrected item-total correlations and exploratory factor analysis were conducted to examine construct structure, employing the KMO measure and Bartlett's test. Bivariate analyses explored associations between key predictors and outcome variables.

A multivariable linear regression model was fitted to identify independent predictors of SCD knowledge score, with year of study, formal SCD training, personally knowing someone with SCD, age, and gender entered a priori. Age and year of study were both retained despite their conceptual overlap, as they were considered to capture distinct constructs (life-stage maturation versus cumulative curriculum exposure) and were specified a priori as covariates rather than effect modifiers; interactions (e.g., gender × year of study) were not tested. Variance inflation factors and residual diagnostics (Durbin-Watson, Breusch-Pagan, Shapiro-Wilk) were examined to assess collinearity and model assumptions; full results appear alongside the regression findings in Results.

Regression assumptions were assessed, and results were presented as regression coefficients (β) with 95% confidence intervals and *P* values. Model performance was evaluated using the adjusted R^2 statistic.

Multivariable modeling focused on knowledge score as the primary quantitative outcome. Other domains were analyzed descriptively or explored in bivariate analyses, consistent with the study's exploratory aims.

Ethical Considerations

This was an anonymous, voluntary survey among adult medical students; no personally identifiable information was collected, and the study was designed to pose no more than minimal foreseeable risk to respondents. However, formal institutional ethical review was not obtained prior to data collection. We report this transparently as a limitation rather than an accepted exemption, since eligibility for exemption from ethical review is normally determined by an accredited research ethics committee, not by investigators themselves; readers should interpret the findings with this limitation in mind. We recommend that future studies of this kind obtain prospective institutional ethical approval, or a documented exemption determination from an accredited research ethics committee, before data collection begins.

Electronic informed consent was obtained from all participants before access to the questionnaire. Participants were provided with clear information about the study's purpose, the voluntary nature of participation, the right to withdraw at any time without consequences, and the measures taken to ensure confidentiality and data protection.

Results

Sociodemographic Characteristics of Respondents

A total of 333 medical students from various institutions in Cameroon participated in the study, with a mean age of 21.5 years and a majority being female. About two thirds had formal training on sickle cell disease (SCD), and nearly half knew someone living with SCD. Detailed characteristics are in Table 1.

Knowledge of Sickle Cell Disease

Knowledge was assessed using seven questions (1 = correct; 0 = incorrect/"don't know"), yielding a total score from 0 to 7. Participants were categorized into low (0–2), moderate (3–5), and high (6–7) knowledge. Overall knowledge of SCD was moderate to high among respondents. The mean knowledge score was 5.17 out of 7, with the majority of students categorized as having moderate knowledge and a substantial proportion demonstrating high knowledge (Figure 1). Knowledge increased significantly with advancing years of study.

Item-level analysis revealed a near-universal understanding of foundational concepts, including the genetic cause of SCD, inheritance patterns, and infection susceptibility associated with splenic dysfunction. Knowledge gaps persisted in clinically relevant areas, including disease-modifying therapies and curative options (Table 2).

Diagnostic knowledge was high: 95.2% of respondents correctly identified hemoglobin electrophoresis as the essential diagnostic test for SCD, while only small proportions incorrectly selected complete blood count or unrelated tests (Table 3). Correct identification was more frequent among students with formal SCD training (97.3%) than without (91.2%), and accuracy increased steadily with advancing year of study, reaching near-universal correctness in senior clinical years.

Understanding of prevention was similarly strong: 98.5% of respondents identified genetic counseling and premarital testing as the appropriate preventive strategy, with fewer than 1% selecting incorrect options such as avoiding strenuous exercise or taking antibiotics regularly, and the same proportion agreed that premarital genetic counseling and testing should be encouraged in Cameroon, with consistently high endorsement across regions (Table 3).

Perceived Stigma and Attitudes Toward SCD

Composite scores assessed perceived stigma, attitudes

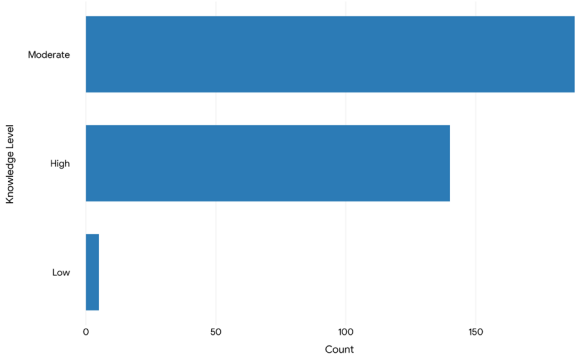


Figure 1. Knowledge level categories

toward Sickle Cell Disease (SCD) care, and perceptions of social determinants using a five-point Likert scale. The mean stigma score was 2.75, indicating moderate stigma endorsement, while attitudes toward care averaged 3.99 and perceptions of social determinants were 3.80. Reliability coefficients were moderate, with Cronbach's alpha values of 0.65 for stigma, 0.69 for attitudes, and 0.61 for social determinants (Tables 4–6). Analysis showed a higher perception of structural and societal stigma, with over 50% agreeing that families are seen as "cursed" and employers are reluctant to hire individuals with SCD. In healthcare, lower stigma was perceived, with 19.5% thinking providers assume patients exaggerate pain and 17.7% noting avoidance by medical professionals.

Attitudes toward caring for individuals with SCD were largely positive. Many respondents (81.4%) reported feeling comfortable treating patients with SCD, and 84.4% agreed that SCD should be covered more thoroughly in the medical curriculum. A smaller majority felt confident addressing the social issues like stigma or poverty faced by people with SCD (68.2%), and a similar proportion believed that people with SCD can live fulfilling, normal lives (69.1%).

Perceptions of the social determinants of SCD, assessed via a separate five-item Likert scale (distinct from the four-item attitude scale above), showed strong endorsement of the need for community education and awareness, alongside somewhat lower but still notable endorsement of exclusion- and isolation-related items (Table 6).

Perceived Social Determinants of Quality of Life

Asked which factors most affect the quality of life of people living with SCD in Cameroon, respondents most frequently selected poverty, treatment and medicine costs, and stigma or discrimination, followed by lack of public awareness, limited government support, and cultural beliefs, underscoring the prominence of social and structural determinants in shaping their lived experiences.

Advocacy Awareness and Engagement

Attitudes towards advocacy for Sickle Cell Disease (SCD) were largely positive, with 82.6% of respondents willing to volunteer in support programs, yet only 36.3% had participated in awareness campaigns, highlighting a disconnect between readiness and actual engagement. Most respondents suggested organizing awareness campaigns and seminars as the primary advocacy strategy, with a noted need for structured guidance for medical trainees. Willingness to volunteer remained high throughout training years, while actual campaign participation increased with age, indicating that greater clinical exposure may enhance real-world engagement.

Qualitative Findings

Qualitative analysis of responses identified key challenges related to sickle cell disease (SCD) (Table 7), mainly stigma and discrimination, economic hardship, lack of public awareness, social isolation, and healthcare barriers. Students advocated for enhanced SCD education, focusing on social determinants of health, patient-centered care, and

Table 2. Item-level knowledge of sickle cell disease

Knowledge item	% Correct
Genetic cause of SCD	99.7
Inheritance pattern (AS × AS)	97.6
The most frequent complication is pain crises (vaso-occlusive episodes)	57.7
Increased infection risk due to splenic dysfunction	92.2
Importance of newborn screening	88.9
Hydroxyurea reduces complications	58.0
SCD can be cured completely	22.5

Table 3. Knowledge of SCD diagnosis and prevention

Item	n	%
Correctly identified hemoglobin electrophoresis	317	95.2
Identified genetic counseling as prevention	328	98.5
Support the encouragement of premarital testing	328	98.5

Table 4. Item-level perceptions of stigma related to SCD

Stigma item	Agree (%)	Strongly agree (%)
Families seen as cursed/unlucky	50.2	12.6
Employers are less willing to hire	52.0	12.6
People with SCD are blamed by society	22.5	4.5
Providers assume pain exaggeration	19.5	5.1
Students/doctors avoid SCD patients	17.7	3.6

Table 5. Attitudes toward SCD care and education

Attitude item	Agree / Strongly agree (%)
Comfortable treating SCD patients	81.4
SCD should be covered more in the curriculum	84.4
Confident in addressing social issues	68.2
People with SCD can live fulfilling, normal lives	69.1

Table 6. Perceived social determinants of health (Likert-scale items, N = 333)

Social determinant perception item	Agree / Strongly agree (%)
Communities need more education about SCD to reduce stigma	93.1
Public awareness of SCD in Cameroon is insufficient	76.3
People with SCD are at risk of economic hardship due to frequent medical visits	77.8
People with SCD are sometimes excluded from school or educational opportunities	36.0
People with SCD face social isolation because of their condition	47.1

Table 7. Qualitative themes from open-ended responses

Domain	Key themes
Social challenges of SCD	Stigma; economic hardship; lack of awareness; social isolation; healthcare barriers
Suggested curriculum changes	More SCD teaching, social determinants, patient-centered care, community engagement
Influence of training	Improved understanding, empathy, awareness of burden, and professional readiness

community outreach. Medical training improved students' understanding and empathy towards patients with SCD, increasing their confidence and readiness to manage cases effectively.

Illustrative Quotations

To ground the domains in Table 7 in participants' own words, illustrative examples are provided below, each identified by an anonymized respondent ID reflecting survey completion order.

Stigma and discrimination: *"Most SCD patients suffer stigmatization. In most parts of Cameroon, people see SCD as a result of witchcraft and other evil practices by their parents."* (Respondent 16)

Economic hardship: *"The lack of a free management program against sickle cell disease through the availability and reduction of care costs, as well as the demystification of the disease."* (Respondent 43)

Lack of public awareness: *"Population ignorance on management and seriousness of the disease."* (Respondent 191)

Social isolation: *"I think the fact that people isolate them and sometimes want nothing to do with them because of their condition. They cannot live like normal people due to the stigma."* (Respondent 329)

Healthcare-related barriers: *"Stigma and discrimination with respect to their physical appearance, the cost of the treatments, the frequent hospitalization and vaso-occlusive crisis which can have an effect on their psyche."* (Respondent 128)

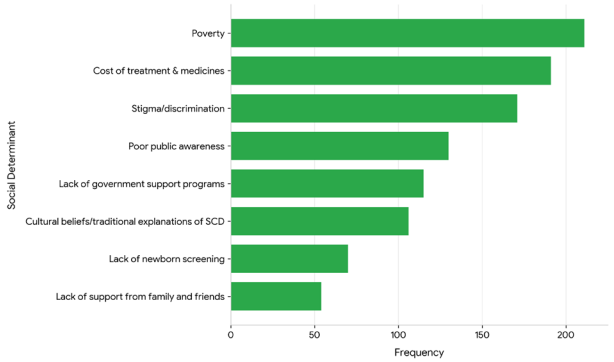


Figure 2. Perceived social determinants affecting quality of life

A basic word-frequency analysis of all open-ended responses corroborated these themes, with "stigma," "discrimination," "awareness," "poverty," "cost," "treatment," and "support" among the most frequent terms, consistent with the domains in Table 7.

Scale Reliability and Structure

To evaluate the psychometric properties of composite scales, a sample of 333 was used, and corrected item-total correlations and exploratory factor analysis were conducted. The stigma scale showed item-total correlations ranging from 0.31 to 0.49, explaining 41.8% of the variance with one dominant factor. The attitude scale demonstrated similar results, with correlations ranging from 0.38 to 0.57 and 52.3% of variance explained. Conversely, the social determinants perception scale had correlations from 0.30 to 0.43, and while its sampling adequacy was acceptable, two factors emerged, indicating potential multidimensionality. Overall, the stigma and attitude scales showed strong coherence, while the interpretation of the social determinants scale requires caution until further validation is performed.

Factors Associated with SCD Knowledge, Stigma, and Attitudes

In a study examining knowledge and stigma related to Sickle Cell Disease (SCD), bivariate analyses (Table 8) revealed that students with formal SCD training had significantly higher mean knowledge scores (5.32) compared to those without training (4.87; $P = 0.001$), indicating a small-to-moderate effect size (Cohen's $d = 0.38$). Notably, knowledge scores varied significantly by year of study ($F(6,326) = 16.15$; $P < 0.001$), showing a large effect ($\eta^2 = 0.23$) and illustrating that knowledge increases with advancing academic level.

Table 8. Summary of bivariate and multivariable analyses of factors associated with SCD knowledge, stigma, and attitude scores

Outcome	Predictor	Group estimates	95% CI	*P* value
Knowledge total (0–7)	Formal SCD training (No vs Yes)	Mean(No)=4.87; Mean(Yes)=5.32	[-0.723, -0.179] (No – Yes)	**0.00125**
Stigma mean (1–5)	Know someone with SCD (No vs Yes)	Mean(No)=2.72; Mean(Yes)=2.78	[-0.218, 0.101] (No – Yes)	0.472
Knowledge total (0–7)	Year of study (7 levels)	Between-group effect present	$\eta^2 = 0.23$ [0.16, 1.00]	**< 0.001**
Attitude mean (1–5)	Stigma mean (1–5)	r = 0.0386	[-0.069, 0.145]	0.483
Attitude mean (1–5)	Stigma mean (1–5)	ρ = 0.0207	—	0.707
Multivariable linear regression predicting SCD knowledge score				
Predictor		**Adjusted β**	**95% CI**	***P* value**
Training: Yes (ref=No)		0.06	−0.20 - 0.31	0.67
Know someone with SCD: Yes (ref=No)		0.14	−0.10 - 0.37	0.25
Year of study (linear trend)		1.83	1.37 - 2.29	**<0.001**
Gender: Male (ref=Female)		−0.06	−0.29 - 0.17	0.62
Age (years)		−0.06	−0.11 - −0.01	0.02

Conversely, knowing someone with SCD did not correlate with stigma scores ($P = 0.47$), and a negligible correlation was found between stigma and attitude scores.

A multivariable linear regression model (Table 8) aimed to identify independent predictors of SCD knowledge, accounting for training, personal connections to SCD, year of study, gender, and age, and explained approximately 24% of the knowledge score variance (adjusted $R^2 = 0.236$; $P < 0.001$). The year of study emerged as the most significant predictor of knowledge, showing a marked positive linear trend ($P < 0.001$). After adjustments, formal training and personal acquaintance with SCD were no longer significantly correlated with knowledge scores, while increased age was linked to a small, significant decrease in knowledge. Gender showed no substantial relationship with knowledge scores.

Collinearity diagnostics indicated no major issues, with variance inflation factors remaining below conventional thresholds. Residual diagnostics provided reassurance, with no evidence of heteroscedasticity ($P = 0.29$) and no significant autocorrelation (Durbin-Watson statistic = 1.76). A minor departure from normality was noted ($P = 0.004$) but was not expected to bias the results significantly, backed by robust sample size. The sensitivity analysis of the regression model further confirmed the significant positive association with the year of study and a small negative association with age (Table 7).

To test the association between age and year of study and student clustering, two analyses were conducted. In the first, removing age from the model still showed year of study as a strong predictor (b = 0.31, $P < .001$), indicating age had minimal unique impact. The second analysis utilized a linear mixed-effects model, revealing an intraclass correlation of 0.12 and reaffirming year of study as a significant predictor (b = 0.39, $P < .001$), while the age's negative correlation became non-significant (b = -0.04, $P = .13$). This suggests age's earlier observed effect was influenced by institutional factors.

Further analysis disaggregated knowledge scores into a Foundational Genetics/Diagnostics sub-domain (mean 3.78, KR-20 = 0.10) and a Clinical Management/Therapeutics sub-domain (mean 1.38, KR-20 = 0.30) with weak correlation (r = 0.28). Year of study predicted Clinical Management (b = 0.26, $P < .001$), while age did not (b = -0.03, $P = .16$). This indicates greater curricular exposure primarily enhances applied clinical knowledge.

Finally, a two-factor structure of the Social Determinants scale was reaffirmed, identifying an "Awareness and Economic Barriers" sub-scale (Cronbach's alpha = 0.64) and a "Structural Exclusion" sub-scale (Cronbach's alpha = 0.65), both demonstrating improved consistency, suggesting these sub-scales should replace the original composite in future analyses.

Discussion

This study evaluates Cameroonian medical students' knowledge and attitudes toward sickle cell disease (SCD) through a mixed-methods approach. It highlights that nearly all participants recognized SCD as hereditary and understood its genetic basis, confirming findings from other African studies. This indicates effective preclinical education in genetics, though the study's cross-sectional design limits causal conclusions.[13]

However, significant gaps remained in clinically focused areas: fewer than 25% of respondents knew SCD is not curable, and fewer than 60% correctly identified hydroxyurea as disease-modifying. Similar gaps are reported among trainees in Nigeria, Uganda, and the Democratic Republic of the Congo, where hydroxyurea and other advanced therapeutic options are often unfamiliar despite strong evidence of efficacy, underscoring the need for more systematic integration of modern SCD management into the medical curriculum.[8]

By contrast, diagnostic and preventive knowledge was notably strong: nearly all participants identified premarital genetic counseling and testing as important preventive measures, and over 95% correctly identified hemoglobin electrophoresis as the key diagnostic test. This exceeds diagnostic awareness reported in several Asian and African studies, where screening and confirmatory testing are more often confused, and is consistent with broader evidence of favorable attitudes toward genetic screening among African students, though actual population-level uptake remains below ideal.[14]

Most students expressed comfort treating patients with SCD and believed they could lead fulfilling lives, consistent with earlier research showing that management knowledge gaps often persist alongside positive attitudinal profiles.[7,8,13,15,16]

Item-level analysis, however, showed stigmatization remains a concern, particularly at societal and structural levels: many respondents believed families with SCD are "cursed" and that employers are less willing to hire people with SCD, mirroring structural stigma patterns documented across sub-Saharan Africa, driven by cultural beliefs, misinformation, and anxieties about chronic illness.[12] Fewer students, encouragingly, supported stigmatizing views within healthcare settings, suggesting medical education may attenuate unfavorable clinical attitudes; still, given evidence that dismissive attitudes toward pain undermine patient trust and outcomes, even moderate levels of perceived healthcare stigma warrant attention.

The strong endorsement of community education and curriculum expansion reflects high student awareness of stigma's social consequences, aligning with qualitative studies in Cameroon, Ghana, and Tanzania emphasizing the central role of education and healthcare-worker training in reducing SCD-related stigma.[17]

Willingness to engage in SCD advocacy was high, but actual participation was low, reflecting a broader pattern in which young people express strong pro-social intent but lack access to structured advocacy opportunities.[18] Similar gaps appear in public health and medical education programs for non-communicable diseases, including SCD, where experiential learning is often insufficiently integrated into training.[19,20] This suggests institutional support and

mentorship are needed to translate positive attitudes into sustained advocacy and community engagement.

The qualitative findings reinforced the quantitative results by highlighting students' perceptions of stigma, financial hardship, low public awareness, and healthcare barriers facing people with SCD. Responses consistently called for more curriculum content on social factors, patient-centered care, and community involvement, and students reported that medical training enhanced their comprehension, empathy, and workforce readiness, particularly in later years. Combining advocacy opportunities with systematic instruction on pain management, stigma reduction, and communication skills may help address these gaps while reinforcing existing positive attitudes.

Strengths and Limitations

A major strength of the study is its mixed-methods design, which enabled a detailed examination of medical students' knowledge, attitudes, and perceived stigma regarding sickle cell disease (SCD). By combining quantitative and qualitative data, the research provided deeper insights into statistical trends and participants' views. The sample included a diverse range of medical institutions and training years, but findings should be viewed as exploratory due to reliance on convenience and snowball sampling. Additionally, a thorough questionnaire assessed biomedical knowledge and stigma, enabling detailed analysis that informs curriculum development and policy, while also highlighting advocacy needs in public health.

This study notes several limitations: a cross-sectional design hinders causal inference and lacks ethical review; convenience and snowball sampling via student associations introduces self-selection bias, affecting generalizability; custom scales lack formal validation, although post hoc analyses support some measures; a composite knowledge score obscures differences in foundational versus clinical knowledge; a mixed-effects analysis reveals that year of study, not age, predicts knowledge; new stigma, attitude, and social-determinants scales require further validation due to low internal consistency. Overall, findings are exploratory and not generalizable to all Cameroonian medical students.

Conclusion

Medical students in Cameroon demonstrate strong foundational knowledge of SCD genetics, diagnostics, and prevention, as well as generally positive attitudes toward patient care. Nonetheless, gaps in clinical management knowledge and persistent perceptions of societal stigma highlight important areas for educational intervention. Strengthening curricula to emphasize disease-modifying therapies, pain management, social determinants of health, and advocacy engagement may better prepare future physicians to provide comprehensive, compassionate care for people living with SCD.

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Competing Interests

The authors declare that they have no competing interests.

Consent to Participate

All participants provided freely-given informed consent, orally, prior to participation.

Consent to Publish

Not applicable; no identifiable personal data were collected.

Data Availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical Approval

Formal ethical approval was not obtained prior to data collection. The study was an anonymous, voluntary, minimal-risk survey of medical students and did not involve clinical interventions, biological sampling, or the collection of directly identifiable personal data. All participants were informed of the study purpose and provided informed consent before participation. Participation was voluntary, and data were stored securely and reported only in aggregate or with non-identifiable quotations. The authors acknowledge the absence of prior ethical approval as a limitation of this study.

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