KNOWLEDGE, ATTITUDES, AND PRACTICES OF HEALTHCARE PROFESSIONALS REGARDING SICKLE CELL DISEASE AND OXIDATIVE STRESS IN LUBUMBASHI

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Abstract

Background: Sickle cell disease (SCD) is a critical public health challenge across sub-Saharan Africa. Oxidative stress is integral to the pathophysiology of this disease. Health professionals' (HCWs') knowledge has an important role in the quality of patient care. This study evaluated knowledge, attitudes, and practices (KAP) of HCWs in Lubumbashi toward SCD with a particular focus on oxidative stress.

Methods: A descriptive cross-sectional study was done over four months (August-November 2022) in 11 healthcare facilities in Lubumbashi. The sample consisted of 532 HCWs, including physicians, medical biologists, and nurses. Data were analyzed using Epi Info version 3.5.4. Associations were assessed using chi-square tests and relative risk (RR) calculations.

Results: Almost all HCWs (90.0%) saw SCD as a public health issue. Nevertheless, significant gaps in knowledge were found for oxidative stress; only 42.7% of those interviewed knew about oxidative stress in SCD while significantly fewer among those who did know about free radical production (33.5%). Doctors had significantly higher knowledge than the rest of HCWs, especially about oxidative stress (RR = 5.0, $p < 0.001$). 75.8% respondents had managed SCD patients and 76.7% knew key preventive measures.

Conclusion : Overall, HCWs in Lubumbashi have good general knowledge of SCD, yet relatively little knowledge about its association with oxidative stress; these results emphasize an urgent need for continuing education which is targeted towards SCD management by healthcare workers, particularly nurses and medical biologists.

Keywords: Sickle Cell Disease, Healthcare Workers, Knowledge Attitudes Practices, Oxidative Stress, Democratic Republic Of Congo.

1. INTRODUCTION

Sickle cell disease is a major public health problem worldwide, affecting more than 500,000 newborns each year, the vast majority in resource-limited countries in sub-Saharan Africa (1,2). The Democratic Republic of Congo (DRC) bears a substantial share of this burden; it is estimated that 2% of newborns are homozygous for hemoglobin S and that around 40,000 children are born each year with sickle cell disease (3). In Lubumbashi, the epicenter of this study, 3.47% of newborns were carriers of a major sickle cell syndrome, underlining its crucial local importance (4).

Although the clinical manifestations of sickle cell disease are well documented, its underlying pathophysiology is based on a fundamental biochemical mechanism: oxidative stress (5,6). The particular propensity of hemoglobin S to polymerize under deoxygenated conditions is exacerbated by a chronic state of oxidative damage. This results in recurrent vaso-occlusive events, hemolysis and endothelial dysfunction, leading to multisystem lesions (6). Understanding this oxidative cascade is not a purely theoretical exercise; it is essential for appreciating disease severity, anticipating complications and guiding potential adjunctive antioxidant therapies (7).

The quality of care and the reduction of complications in patients with sickle cell disease intrinsically depend on the knowledge and practices of frontline healthcare professionals (8). In the DRC, studies have revealed gaps in general knowledge of sickle cell disease among physicians and a tendency for families to seek care outside the formal health system (9,10). However, current assessments of healthcare professionals' competencies focus mainly on general clinical knowledge (11).

This is where the critical gap and originality of our study lie. To our knowledge, no previous research in the DRC – and few in comparable contexts – has specifically examined whether healthcare professionals have a fundamental understanding of the role of oxidative stress in sickle cell disease. Such knowledge represents a deeper level of understanding than simple symptomatology and is essential for holistic patient management. Are healthcare workers aware of the invisible biochemical mechanism underlying the visible clinical crises?

This cross-sectional study was therefore designed to assess the knowledge, attitudes and practices of physicians, medical biologists and nurses in Lubumbashi regarding sickle cell disease, with a particular focus on their understanding of the central role of oxidative stress in the pathophysiology of the disease.

2. METHODS

Study design and setting: A descriptive cross-sectional study was conducted over a four-month period, from 1 August to 30 November 2022. The study took place in 11 healthcare facilities (9 public and 2 private) in Lubumbashi, Democratic Republic of Congo. These facilities were selected so as to include the main referral hospitals (for example, HGR Janson-Sendwe) and thus ensure a diversified representation of healthcare staff within the study population.

- Study population and sampling: The study population comprised practising healthcare professionals from three professions: physicians, medical biologists and nurses. Eligible participants were required to have at least six months of clinical or laboratory experience and to provide written informed consent. For operational reasons, convenience sampling was used. The sample size was not predetermined; the objective was to recruit as many participants as possible over the entire study period. The final sample consisted of 532 healthcare professionals.
- Data collection instrument and procedure: Data were collected using a structured, self-administered questionnaire in French, created specifically for this study. The questionnaire was developed after a literature review of KAP (knowledge, attitudes and practices) studies on sickle cell disease and of clinical management guidelines for this condition. It included 35 questions divided into four sub-sections:
    1) Demographic and professional data (8 items: age, sex, profession, years of experience, workplace, etc.).
    2) General knowledge of sickle cell disease (15 items: epidemiology, genetics, clinical presentation, complications, diagnosis, prevention).
    3) Knowledge of oxidative stress in sickle cell disease (7 items: definition of oxidative stress and free radicals, their production in sickle cell disease, their biological impacts and protective measures).
    4) Attitudes and practices (5 items: frequency of managing patients with sickle cell disease, preference for diagnosis versus patient support).

The questionnaire was pre-tested among 20 healthcare professionals (who did not take part in the main study) to assess clarity, comprehension and face validity. Several wording modifications were made following their feedback. The main survey consisted of field data collection carried out by trained research assistants, final-year medical students. They administered the questionnaires, obtained informed consent and were available to answer any questions from participants without influencing their responses.

- Themes, data collection and analysis: Data were entered into a Microsoft Excel spreadsheet and analysed using Epi Info version 3.5.4 (CDC, Atlanta, USA). Categorical variables were summarised as frequencies and percentages. Continuous variables (such as age) were presented as means and standard deviations. For knowledge questions, a correct answer was coded as “1” and an incorrect or unknown answer as “0”. No composite knowledge score was created for this study; instead, responses to key questions were examined individually to identify specific gaps. The chi-square test (or Fisher’s exact test where appropriate) was used to compare the proportions of correct answers between professional categories. Relative risk (RR) and 95% confidence intervals were calculated to quantify the strength of associations. A p-value below 0.05 was considered statistically significant.
- Ethical considerations: The study was approved by the Medical Ethics Committee of the University of Lubumbashi (authorisation UNILU/CEM/100/2022 dated 3 June 2022). Written informed consent was obtained from all participants. Confidentiality was ensured by using anonymous questionnaires; no personal identifying data were collected.

3. RESULTS

3.1.Sociodemographic and Professional Characteristics of Participants

A total of 532 healthcare professionals participated in the study. The sample was almost equally distributed between sexes (51.7% men and 48.3% women). The mean age of respondents was 34.43 ± 8.43 years, with the 30-39 age group being the most represented (52.3%). Nurses accounted for half of the sample (50.4%), followed by physicians (39.7%) and medical biologists (10.0%). Most participants (61.7%) had less than 10 years of professional experience. Regarding specific training on sickle cell disease, 52.8% reported having received it during their initial training, while 19.2% had attended continuing education on the subject. Janson-Sendwe Provincial Reference Hospital was the most represented healthcare facility (24.6%) (Table 1).

3.2.Knowledge of Sickle Cell Disease: General Aspects and Oxidative Stress by Professional Category

Participants showed good knowledge of the general aspects of sickle cell disease. A large majority recognised sickle cell disease as a public health problem (90.0%) and as a qualitative hemoglobin anomaly (85.7%). More than three-quarters correctly identified the main reasons for consultation (78.9%) and common complications (76.9%) of sickle cell disease (Table 2).

However, knowledge regarding the genetic transmission of sickle cell disease was weaker, with only 55.6% of respondents correctly identifying its autosomal recessive nature. More worryingly, a major knowledge deficit was observed regarding the role of oxidative stress. Less than half of respondents knew the concept of oxidative stress (42.7%) or free radicals (41.2%). Even fewer knew that free radicals are produced in sickle cell disease (33.5%) or understood the main consequences of this overproduction (44.0%). All of these proportions, covering both general knowledge of sickle cell disease and concepts related to oxidative stress, are illustrated in Figure 1.

3.3.Knowledge and Practices by Professional Categories

Physicians consistently demonstrated a higher level of knowledge than medical biologists and nurses. This difference was particularly marked for oxidative stress. For example, while a majority of physicians were familiar with this concept, this was true for only a minority of nurses and biologists. A strong and statistically significant association was found between professional category and knowledge of oxidative stress in sickle cell disease: physicians were nearly five times more likely to be aware of this link than other healthcare professionals (RR = 4.99, 95% CI: 3.88–6.44, $p < 0.001$), as detailed in Table 2. Significant associations were also observed regarding knowledge of the qualitative hemoglobin anomaly, prevention methods, genetic transmission and confirmatory testing for sickle cell disease ($p < 0.05$ for all).

3.4.Attitudes, Practices and Patient Management

A high proportion of healthcare professionals (75.8%) reported having already managed a patient with sickle cell disease. Most respondents knew the main methods for preventing sickle cell crises (76.7%) as well as screening tests (63.4%) and confirmatory tests (70.7%) for sickle cell disease. In addition, 73.7% knew that children with sickle cell disease should be exempted from intense physical exercise, and 70.5% had good

knowledge of hygiene and dietary advice to give to patients. In contrast, knowledge was poor regarding the first line of defence against oxidative stress, with only 0.6% correct answers.

3.5.Factors Independently Associated with Knowledge of Oxidative Stress

In this multivariate analysis, professional category remained independently associated with knowledge of oxidative stress after adjustment for age, professional experience and prior training. Physicians were significantly more likely to master the concept of oxidative stress than other healthcare workers (aOR = 4.62; $p < 0.001$). Prior training on sickle cell disease was also an independent factor associated with better knowledge (aOR = 1.89; $p = 0.001$). Age and professional experience were not significantly associated with better knowledge after adjustment. These results are detailed in Table 3.

4. DISCUSSION

This cross-sectional study aims to provide new insight into the knowledge, attitudes and practices of healthcare professionals in Lubumbashi regarding sickle cell disease, particularly oxidative stress. The main finding is that, although the vast majority of healthcare professionals have solid general knowledge of sickle cell disease, their understanding of the role of oxidative stress in the pathophysiology of the disease remains limited and concerning, as illustrated by Figure 1. This is especially true in the Democratic Republic of Congo, where the prevalence of sickle cell disease is high and resources for managing complications are limited. The high level of awareness of sickle cell disease as a public health problem (90.0%) and of its clinical manifestations is consistent with the high local prevalence of the disease (4) and with findings from other studies conducted in the DRC (12).

Our results suggest that this general knowledge does not necessarily translate into an understanding of the underlying pathophysiological mechanisms. The fact that less than half of respondents were familiar with oxidative stress (42.7%) and that even fewer knew about free radical production in sickle cell disease (33.5%) reveals a major gap in comprehensive disease management. The most notable result is the strong correlation between professional category and knowledge level. Physicians have markedly better knowledge than nurses and medical biologists regarding oxidative stress (RR = 4.99, 95% CI: 3.88–6.44). This is probably due to differences in training curricula; medical education is more comprehensive in terms of pathophysiology and covers more biochemistry than nursing and technical training. This training deficit may hinder effective team collaboration and comprehensive patient care, since different types of healthcare professionals intervene with varying levels of understanding of fundamental disease processes.

Our findings are consistent with previous research conducted in various settings that has highlighted knowledge gaps among healthcare professionals managing patients with sickle cell disease (13). However, this study is distinctive in that it specifically identifies oxidative stress as the deficient area. The clinical importance of this finding is considerable. Because oxidative stress contributes significantly to vaso-occlusive crises and chronic organ damage in sickle cell disease (14), clinicians who are not familiar with this process may limit themselves to symptomatic measures rather than adopting concrete strategies to reduce oxidative damage.

The multivariate analysis confirms that professional category remains an independent determinant of knowledge of oxidative stress, even after adjustment for other factors. In contrast, neither age nor professional seniority was independently associated with better knowledge, suggesting that exposure over time alone does not guarantee an adequate understanding of sickle cell disease mechanisms. By contrast, having received prior training on sickle cell disease was an independent predictor of better knowledge, highlighting the importance of structured education.

From a public health perspective, these results show that it is necessary to implement targeted continuing education programmes focused on pathophysiological mechanisms, including oxidative stress, particularly for non-physician healthcare workers who play a key role in day-to-day patient management.

5. CONCLUSION

Our results demonstrate a substantial need for training among healthcare professionals in Lubumbashi. We recommend integrating content on oxidative stress and the pathophysiology of sickle cell disease into initial and continuing training modules, particularly for nurses and medical biologists. Future research should assess the impact of such educational interventions on improving knowledge and clinical outcomes. Bridging this gap is essential to ensure comprehensive, evidence-based management of sickle cell disease in the Democratic Republic of Congo.

Study limitations : There are a few limitations that should be noted in interpreting these findings. Convenience sampling could also impact on the generalizability of our results. The cross-sectional design gives us an overview of knowledge at a single point and we cannot measure progression of knowledge. Responses may be subject to social desirability bias as in the case for all questionnaire-based studies though anonymity likely minimised this influence. Last, but not least, knowledge was assessed with no direct comparison to clinical practice.

Competing interests

The authors declare no competing interests.

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by TKE, KIE & BEM. The first draft of the manuscript was written by TKE, SPM, KLC & NBV and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Table 1. Socio-demographic and professional characteristics of the study participants (N=532)

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	275	51.7
	Female	257	48.3
Age Group (years)	20-29	94	17.7
	30-39	278	52.3

	40-49	128	24.1
	50-59	24	4.5
	≥60	8	1.5
Mean Age ± SD (years)	34.43 ± 8.43		
Profession	Physician	211	39.7
	Nurse	268	50.4
	Medical Biologist	53	10.0
Professional Experience (years)	0-10	328	61.7
	11-20	162	30.5
	>20	42	7.9
SCD Training	During basic training	281	52.8
	Continuing education	102	19.2
	No specific training	149	28.0
Main Health Facility	HGR Janson-Sendwe	131	24.6
	HGR Kisanga	58	10.9
	HGR Katuba	51	9.6
	HGR Kenya	50	9.4
	HGR Kamalondo	45	8.5
	HGR Kampemba	45	8.5
	HGR Ruashi	44	8.3
	RMH Camp Vangu	43	8.1
	Private Polyclinic 1	34	6.4
	Private Polyclinic 2	31	5.8

Table 2. Knowledge of sickle cell disease and oxidative stress among healthcare workers, by professional category

Knowledge Item	**Total (N=532) n (%)**	**Physicians (n=211) n (%)**	**Nurses (n=268) n (%)**	**Medical Biologists (n=53) n (%)**	**p-value**	**RR (95% CI)**
General Knowledge						
SCD is a public health problem	479 (90.0)	196 (92.9)	231 86.2	52 98.1	0.751	1.05 (0.99-1.11)
SCD is a qualitative Hb anomaly	456 (85.7)	194 91.9	219 81.72	43 81.1	<0.001	1.13 (1.06-1.20)
Autosomal recessive transmission	296 (55.6)	134 63.5	137 51.1	25 47.2	0.003	1.26 (1.08-1.46)
Knowledge on Oxidative Stress						
Knows the concept of oxidative stress	227 (42.7)	174 82.5	47 17.54	6 11.3	<0.001	4.99 (3.88-6.44)
Knows the concept of free radicals	219 (41.2)	168 79.6	46 17.16	5 2.3	<0.001	5.01 (3.86-6.50)
Free radicals are produced in SCD	178 (33.5)	143 67.8	30 11.2	5 9.4	<0.001	6.19 (4.47-8.58)
Knows major consequences	234 (44.0)	111 52.6	107 39.93	15 6.4	<0.001	1.38 (1.14-1.67)
Practices						
Knows means of prevention	408 (76.7)	177 83.9	202 75.4	29 76.7	0.001	1.17 (1.07-1.28)

Knows confirmatory test	376 (70.7)	165 78.2	177 66.0	9 64.2	0.002	1.19 (1.07-1.32)

Table 3. Multivariate logistic regression analysis of factors associated with knowledge of oxidative stress

Variable	aOR	95% CI	p-value
Physician vs others	4.62	3.21–6.65	<0.001
Prior SCD training	1.89	1.29–2.76	0.001
Age ≥40 years	1.12	0.78–1.61	0.54
Experience ≥10 years	1.08	0.75–1.55	0.67

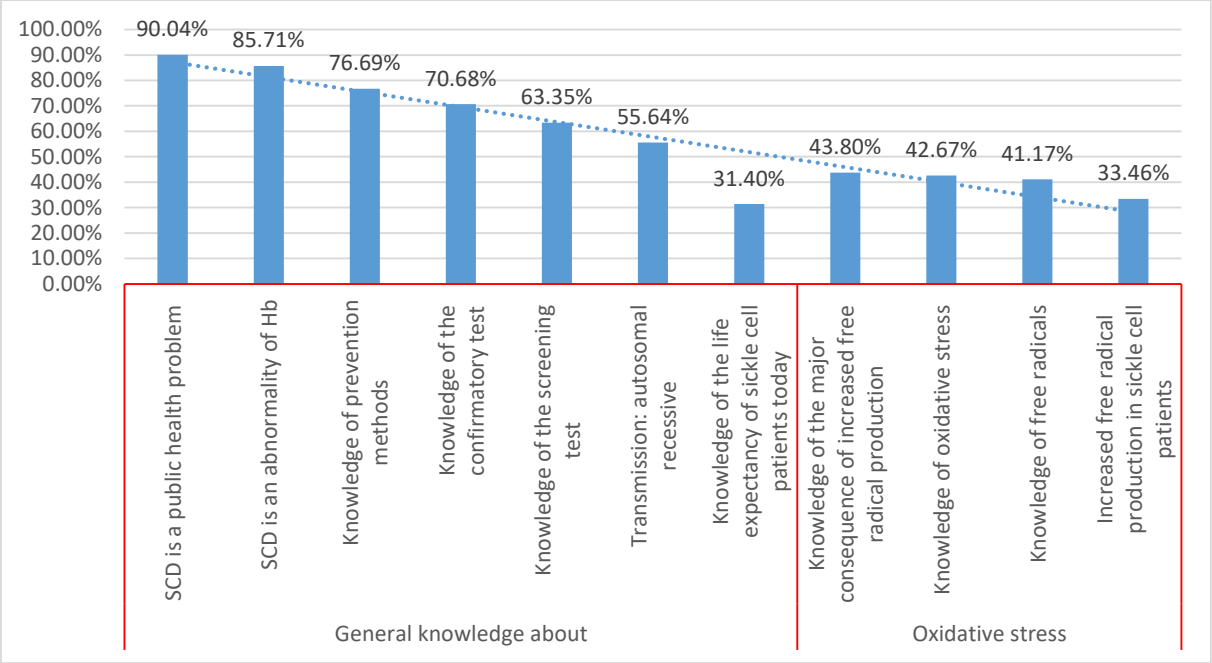

Figure 1. Percentage of correct responses on general knowledge of sickle cell disease and oxidative stress among healthcare professionals (N = 532).