

Factors Influencing the Identification and use of Medicinal Plants in the Treatment of Severe Anemia in Children Under Five Years of Age: a Study Conducted In Kisangani, Democratic Republic Of The Congo.

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Abstract

Introduction: Severe childhood anemia is a major problem in sub-Saharan Africa. Blood transfusion, although the primary treatment, remains costly and risky. The use of medicinal plants appears to be a local alternative that requires scientific validation. This study aimed to identify the plants used, analyze the sociodemographic and economic determinants of plant use, and describe therapeutic practices.

Methods: A descriptive cross-sectional study was conducted in Kisangani (DRC) between April 2024 and June 2025, involving 298 parents recruited by convenience sampling in six peripheral health zones. Data were collected through semi-structured interviews in Lingala and Swahili, then analyzed using SPSS (chi-square and logistic regression).

Results: Participants were predominantly young adults (18–28 years old, 45.7%), married women (78.5%), and had a primary school education (58.4%). More than half (56.3%) were unaware of herbal remedies for anemia. The main symptoms prompting treatment were pallor, fatigue, and fever (28.3%). Leaves (46.6%) and decoctions (47.3%) were the most commonly used forms, administered twice daily (46%). The main sources of supply were the forest (33.3%) and the market (27.8%). The majority (80.3%) justified the use of plants based on the combination of “accessibility, cost, and effectiveness.”

Discussion: These results confirm the importance of herbal medicine as a local alternative. Its integration into hospital settings, accompanied by scientific validation and staff training, would strengthen the management of childhood anemia.

Keywords: Severe anemia, Children under five, Medicinal plants, Therapeutic practices, Blood transfusion

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1. Introduction

Anemia is a major global public health problem that particularly affects young children and pregnant women. It is defined as a decrease in the level of functional hemoglobin in the blood relative to reference values based on the individual's age, sex, and physiological status (WHO, 2011).

It is a public health issue with major consequences for health as well as for socioeconomic development. The most serious health consequence, which has been widely demonstrated, is the increased risk of maternal and infant mortality

observed in severe cases. It also raises other concerns, ranging from adverse effects on child development and workplace productivity (when anemia is due to iron deficiency) to increased risks of postoperative morbidity and mortality in anemic patients (Touré, 2012).

A decrease in hemoglobin levels results in a reduction in the blood's ability to carry oxygen. However, a low hemoglobin level may be well tolerated. The clinical tolerance of anemia depends on how rapidly it develops and the patient's underlying condition. The more rapidly anemia develops, the greater the risk that the adaptive mechanisms designed to maintain oxygenation will be overwhelmed,

especially if there is a preexisting cardiorespiratory condition (Ucama, 2013).

Thus, in this article, we set out to identify and analyze the use of medicinal plants in the treatment of severe anemia in children in the city of Kisangani.

1.1 Background

Anemia is a global public health problem because it has major consequences for children's health as well as for their parents' socioeconomic development (UNICEF, 2015; Hebert, 2015).

According to the WHO, approximately 50% of cases are due to iron deficiency, and the populations at highest risk remain infants, children, and women of childbearing age. The highest prevalence is observed among preschool-aged children, reaching 47.4% (WHO, 2015).

It is estimated that anemia affects half a billion women aged 15 to 49 and 269 million children aged 6 to 59 months worldwide. In 2019, 30% (539 million) of nonpregnant women and 37% (32 million) of pregnant women aged 15 to 49 suffered from anemia. The main causes were iron deficiency, thalassemia, sickle cell trait, and malaria (Global Health Metrics, 2019).

In the United States, a study shows that the prevalence of anemia among children aged 1 to 5 years was 7.1% for mild anemia, 3.9% for moderate anemia, and 1.1% for severe anemia. The prevalence of iron-deficiency anemia and overall anemia was higher among children aged 1 to 2 years; furthermore, more than 50% of anemic children in this age group had iron deficiency (Gupta et al., 2016).

In Canada, the prevalence of iron-deficiency anemia among Indigenous infants can range from 14% to 50%, while it ranges from 4% to 5% in the general Canadian population (DGPNI, 2012).

In Indonesia, the prevalence of anemia among children aged 6 months to 6 years is 39.8%. It stands at 3% among well-nourished children from low socioeconomic backgrounds and ranges from 85% to 100% among malnourished children. In Latin America, the rate of anemic children ranged from 32.93% to 17.49% depending on the region (PAHO, 2010).

In Brazil, there are no national surveys on the prevalence of anemia. Only studies conducted in various regions indicate a high prevalence of the condition and estimate that approximately 4,800,000 preschool-aged children are affected. These regional data confirm that anemia remains a major problem in Brazil, affecting all age groups and socioeconomic levels (Souza, 2017).

The WHO African Region and the WHO Southeast Asia Region are the most affected, with approximately 106 million women and 103 million children affected by anemia in Africa, compared with 244 million women and 83 million children in Southeast Asia (Walters et al., 2017).

A study conducted in certain French-speaking African countries indicates that 72% of children aged 6 months to 5 years suffer from anemia. The prevalence is slightly lower in Equatorial Africa (Gabon, Congo-Brazzaville, and Cameroon), particularly for severe forms of the disease, which affect only 1 to 2% of children there, compared to 10% in Burkina Faso (Ahmed, 2018).

In Morocco, anemia represents a significant public health problem. The latest national survey conducted by the Ministry of Health showed that the prevalence of anemia among preschool-aged children is 31.5%. To address this problem, Morocco had committed to reducing the prevalence of anemia by one-third by 2015 (Andogo'o, 2015).

Severe anemia is a major cause of death among children. An epidemiological and clinical analysis would help assess the high mortality and morbidity associated with this condition in resource-limited countries. Severe anemia is associated with a high rate of hospital bed occupancy. Severe anemia constitutes a medical emergency that, in most cases, requires blood transfusion. The highest transfusion rates are found in sub-Saharan Africa; in 2000, they were 85.7% in Yaoundé and 70% in Kenya (Demmouche, 2017).

A retrospective and descriptive study conducted at the Katele Referral Health Center in the Moba territory (Tanganyika Province, in the southeastern Democratic Republic of the Congo) reveals that 30.4% of anemic children suffer from decompensated anemia. Children aged 13 to 36 months and female children are the most affected (54.5%). Approximately 7.7% of the children were admitted in a state of anemic coma, and the majority of these cases were transferred from other facilities (Kabemba, 2017).

Transfusion is an important therapeutic tool in combating acute anemia, which threatens the lives of children—especially those under 5 years of age, who account for 85% of cases. However, it is also a risky medical procedure, as it can lead to complications due to incompatibility, anaphylactic shock, or the transmission of infectious diseases. Therefore, the expected benefits must always be weighed against the associated risks (Ndidaka, 2016).

A large number of medicinal plants are known to treat abnormally low hemoglobin levels. It is also recommended to consume fruits and vegetables that are particularly rich in minerals and B vitamins (George and Pamplona, 2021).

In Kisangani, the capital of Tshopo Province (DRC), Bulaya (2020) demonstrated in his study that the use of traditional plants, particularly *Arnica montana*, was effective in combating anemia in children by increasing their hemoglobin levels. Before taking *Arnica montana*, 50.9% of the subjects had hemoglobin levels between 13 and 16 g/dL. After taking *Arnica montana* in February 2020 (the first month of the trial at the Gracia Foundation Health Center

laboratory), 66.1% of the subjects had hemoglobin levels ranging from 15 to 18 g/dL. In March 2020, this percentage dropped to 52.8% for the 10–12 g/dL range, and by April 2020, it had stabilized between 13 and 15 g/dL in 56.6% of cases.

Makelele Leonard (2015), in his study on medicinal plants used to treat anemia in patients with sickle cell disease in Kisangani, demonstrated that 90% of the plants cited had anti-anemic and anti-falciform effects, resulting in the reversion of sickle-shaped red blood cells to oval shapes.

Thus, this article focuses on the identification and use of medicinal plants in the treatment of severe anemia in children in the city of Kisangani. To better present this study, we have structured it into three sections: the first presents the methodological framework, in which we review the study setting, the population, the sample, and the data collection and processing techniques. The second section presents the results of our research, while the third is devoted to the discussion.

Given this situation, we will attempt to answer the following questions:

1. How do parents identify medicinal plants with anti-anemic properties?
2. What are the sociodemographic and economic determinants (income, educational level, accessibility of health centers) that influence the use of herbal medicine over conventional medicine?
3. What are the methods used to prepare and administer these plants to treat severe anemia in children under 5 years of age?

1.2 Research Objectives

1.2.1 General Objective

Severe anemia remains a major public health problem among children under five, particularly in developing regions where it is a common cause of child mortality.

This study is conducted within this context, with the general objective of contributing to the improvement of care for severe anemia in children under five by highlighting the factors that influence the identification of and reliance on medicinal plants

1.2.2 Specific Objectives

We pursue the following specific objectives:

1. To identify the various species of medicinal plants used locally by parents to treat childhood anemia.
2. Determine the sociodemographic and economic factors that influence the use of herbal medicine.
3. To list the methods of preparation and administration of these plants for treating severe anemia in children under 5 years of age.

1.3 Significance of the Study

Several observations indicate that parents of anemic children, for one reason or another, often prefer traditional medicine to blood transfusions to treat anemia. Sometimes, this approach yields favorable results, helping to stabilize the children's health.

Thus, the significance of this study is both scientific and practical:

1.3.1 From a scientific perspective

This study constitutes our contribution to the advancement of research, in that it provides researchers with new data on the treatment of childhood anemia using medicinal plants.

1.3.2 From a practical perspective

The results of this study will enable parents to make informed choices regarding the appropriate management of anemia in their children.

2. Materials and Methods

2.1 Study Setting

The study framework is presented at the beginning of the methodology section to

clarify the approach taken. This is a descriptive, cross-sectional study conducted over a period of fourteen months (from April 15, 2024, to June 30, 2025) in the six peripheral health zones of Kisangani.

The main objective was to analyze the factors influencing the identification and use of medicinal plants in the treatment of severe anemia in children under five years of age, by comparing parents' perceptions regarding the use of medicinal plants and the use of blood transfusions.

General Referral Hospitals, Health Centers, and Private Clinics. However, the local healthcare system faces numerous challenges: a lack of qualified personnel, a shortage of blood products, limited equipment, and difficulties in securing essential medications.

Pediatric departments are particularly overburdened due to the high prevalence of infectious diseases and childhood anemia. Access to care remains unequal, concentrated in urban areas, while the high costs of blood transfusions drive families to turn to herbal remedies, which are considered more accessible.

Kisangani was chosen as the study site due to the high prevalence of anemia, the coexistence of biomedical and traditional practices, and the lack of local quantitative studies.

2.2 Methods

For this study, we adopted a descriptive quantitative approach aimed at exploring parents' perceptions regarding the treatment of childhood anemia, comparing blood transfusions with the use of medicinal plants.

The methodology adopted is descriptive in nature. Data were collected in a single phase from the target population through semi-structured interviews guided by a framework

and recorded using a voice recorder, ensuring the reliability and preservation of the information. The analysis was conducted in several stages: reading the narratives, identifying meanings, grouping them into themes, and then validating the findings with the participants.

2.3 Population and Study Sample

2.3.1 Study Population

In this study, the target population consists of parents who are aware of anemia and reside in the city of Kisangani, representing a defined and limited group of 683 individuals. The study took place between April 15, 2024, and June 30, 2025, in the six peripheral health zones of the city of Kisangani: Tshopo Commune: Malkiya Health Zone; Kabondo Commune: Wandungu Health Zone; Makiso Commune: Mac Milan Health Zone; Lubunga Commune: Losoko Health Zone; Mangobo Commune: Segama Health Zone; and Kisangani Commune: Kilanga Health Zone. Participant recruitment took place in the six outlying health zones of Kisangani between April 2024 and June 2025.

- **Assessed for eligibility:** 683 parents were initially identified as the target population because they were aware of anemia and resided in the city of Kisangani.
- **Confirmed as eligible:** 298 parents met the inclusion criteria (having a child under five years of age diagnosed with anemia, having used a herbal treatment, being present during the survey, and voluntarily agreeing to participate).

2.3.2 Study Sample

In this study, we adopted a non-probability sampling design, in which not every member of the target population had an equal probability of being included. The survey was conducted in Kisangani (DRC) among 298 parents who had used herbal treatments for anemia and who lived in the city's six outlying health zones, which are: Tshopo Commune: Malkiya Health Zone (43); Kabondo Commune: Wandungu Health Zone (58); Makiso Commune: Mac Milan Health Zone (27); ; Lubunga Commune: Losoko Health Zone (74); ; Mangobo Commune: Segama Health Zone (34); and Kisangani Commune: Kilanga Health Zone (62); between April 15, 2024, and June 30, 2025, selected according to defined criteria.

The target population consisted of 683 parents identified in the outlying health zones of Kisangani. Based on this, a sample of 298 participants was selected according to specific inclusion criteria (having a child under five years of age diagnosed with anemia and having used medicinal plants for treatment). The sample size was determined based on participant availability and accessibility in the field..

Recruitment was conducted using convenience sampling, based on the availability and accessibility of participants.

This approach aligns with the exploratory nature of the research, which prioritizes statistical representativeness.

A relationship of trust was established from the outset. The interviewer explained the objectives, the terms of participation, and the confidentiality guarantees. The semi-structured interviews were conducted in an atmosphere of respect and active listening, encouraging free expression. Rigor was ensured through clear documentation of the process and feedback to participants for validation of the themes, thereby reinforcing the credibility and transparency of the results. The following selection criteria were applied:

Participant Inclusion Criteria

- Having a child under the age of five who had been diagnosed with anemia in one of the six peripheral health regions;
- Have practiced a treatment for anemia using medicinal plants;
- Be present during the survey;
- Voluntarily agree to participate in the study;

Exclusion Criteria for Participants

Excluded: 385 parents were excluded for various reasons:

- Child older than five years (n = 142)
- No use of medicinal plants to treat anemia (n = 121)
- Anemia treatment dating back more than three months (n = 78)
- Unavailable during the data collection period (n = 32)
- Refusal to participate in the study (n = 12)

Thus, the final sample consisted of **298 participants**, distributed as follows:

- Tshopo (Malkiya): 43
- Kabondo (Wandungu): 58
- Makiso (Mac Milan): 27
- Lubunga (Losoko): 74
- Mangobo (Segama): 34
- Kisangani (Kilanga): 62

2.3.3 Study Design

To achieve the objectives of this study, we used a descriptive cross-sectional approach over 14 months, from April 15, 2024, to June 30, 2025.

2.4 Data Collection Method

2.4.1 Data Collection Method

In this study, we adopted a retrospective, descriptive quantitative method. This approach allows us to understand the reasons for using plants to treat childhood anemia.

2.4.2 Data Collection Technique

Data were collected through individual, semi-structured, face-to-face interviews. This data collection strategy was

chosen for its ability to encourage the free and spontaneous expression of participants, while maintaining a certain degree of structure through the interview guide.

The interviews lasted between 30 and 45 minutes each and took place in the city of Kisangani across six outlying health zones. The data collection period ran from April 15, 2024, to June 30, 2025. The languages used during the interviews were primarily Lingala and Swahili, depending on each parent's language preference.

We used the structured face-to-face interview technique, and to do so, we administered a pre-designed questionnaire to the respondents.

These interviews were conducted directly with the respondents. After providing their identifying information, each respondent was asked to answer a few selected questions designed to analyze the issue of anemia treatment—both using medicinal plants and through blood transfusion—while assuring them that their responses would be treated anonymously.

To this end, a data collection form was prepared in advance, serving as the tool that enabled us to gather information relevant to our research. This data collection form included both open-ended and closed-ended questions.

2.4.3 Data Collection Tools

To ensure the efficient collection and storage of the data needed for analysis, we used the interview guide and a camera, which made it easier to obtain images of the plants. Literature review served as a useful data collection technique.

To facilitate data collection from respondents who did not speak French, the interview guide was initially drafted in French and then translated into Lingala and Swahili.

2.5 Data Analysis Plan

2.5.1 Analysis Tools

The collected data were analyzed using SPSS (Statistical Package for the Social Sciences, version 25.0). Statistical calculations were performed using bivariate descriptive analysis and multivariate logistic regression. Some of the results were presented in statistical tables. A bivariate analysis was performed using the chi-square test to establish

the relationship between the independent variables and the dependent variable at a significance level of 0.05; subsequently, multivariate logistic regression was used to identify significant factors (those with a p-value less than 0.05).

2.6 Biais et mesures de réduction

Plusieurs efforts ont été entrepris pour limiter les biais potentiels :

1. **Biais de sélection** : bien que l'échantillonnage ait été non probabiliste, la diversité des zones de santé couvertes a permis de réduire le risque de surreprésentation d'un groupe particulier.
2. **Biais de mémoire (recall bias)** : les entretiens semi-structurés ont été réalisés en face-à-face, avec un enregistrement audio pour garantir la fidélité des réponses et limiter les erreurs de rappel.
3. **Biais d'interprétation** : les thèmes identifiés ont été validés avec les participants (feedback) afin d'assurer la crédibilité et la compréhension des résultats.
4. **Biais linguistique** : les guides d'entretien ont été traduits en lingala et en swahili pour permettre une meilleure lecture et écoute pour éviter les malentendus.

2.7 Ethical Considerations

Free and informed consent was obtained from the participants, and their participation was voluntary. Participants who agreed to take part in this study were administered a questionnaire. The children, as indirect beneficiaries, were not directly involved in order to preserve their anonymity. The data were stored and secured, with a retention period set such that the data will be destroyed following publication. Anonymized transcripts constituted the sole material used for the analysis. No financial or material compensation was offered, and this absence was clearly explained to avoid any influence on participation. The participants gave their free and informed consent verbally and agreed to participate in the study.

3. Results

3.1 Sociodemographic Characteristics of the Study Participants

Table 1

Distribution of study participants according to their sociodemographic characteristics

Characteristics	Total sample/683	Anemia: Yes n (%)	Anemia: No n (%)	Bivariate analysis (p-value)	Multivariate analysis ORa [95% CI]	p-value (Final model)
Age (years)						
18–28	311	136 (43.7)	175 (56.3)	0.012	1	—

Characteristics	Total sample/683	Anemia: Yes n (%)	Anemia: No n (%)	Bivariate analysis (p-value)	Multivariate analysis ORa [95% CI]	p-value (Final model)
29–39	176	95 (53.9)	81 (46.1)		2.41 [1.15–5.04]	0.021
40–50	122	39 (31.9)	83 (68.1)		1.12 [0.45–2.80]	0.789
51–61	74	28 (37.8)	46 (62.2)		0.85 [0.31–2.21]	0.654
Educational level						
Higher education	92	35 (38.0)	57 (62.0)	0.240	Variable excluded	—
Secondary	233	89 (38.2)*	144 (61.8)		(Since $p \geq 0.20$)	—
Elementary	358	174 (48.6)	184 (51.4)			—
Marital status						
Married	549	234 (42.6)	315 (57.4)	0.004	1	—
Unmarried mother	134	64 (47.7)	70 (52.3)		3.15 [1.89–6.22]	< 0.001
Gender						
Male	102	54 (52.9)	48 (47.1)	0.051	1	—
Female	581	244 (42.0)	337 (58.0)		0.64 [0.41–1.00]	0.051
Occupation						
Government employee	181	69 (38.1)	112 (61.9)	< 0.001	1	—
Housewife	302	103 (34.1)	199 (65.9)		0.84 [0.56–1.26]	0.396
Cultivator	157	95 (60.5)	62 (39.5)		2.49 [1.60–3.87]	< 0.001
Retail	43	31 (72.1)	12 (27.9)		4.19 [2.02–8.70]	< 0.001
Residential community						
Makiso (Mac Milan)	118	27 (22.9)	91 (77.1)	< 0.001	1	—
Tshopo (Malkiya)	101	43 (42.5)	58 (57.5)		2.50 [1.37–4.55]	0.003

Characteristics	Total sample/683	Anemia: Yes n (%)	Anemia: No n (%)	Bivariate analysis (p-value)	Multivariate analysis ORa [95% CI]	p-value (Final model)
Lubunga (Losoko)	117	74 (63.2)	43 (36.8)		5.80 [27–10.29]	< 0.001
Kabondo (Wandungu)	113	58 (51.3)	55 (48.7)		3.55 [2.00–6.32]	< 0.001
Mangobo (Segama)	109	34 (31.2)	75 (68.8)		1.53 [0.82–2.85]	0.183
Kisangani (Kilanga)	125	62 (49.6)	63 (50.4)*		3.32 [1.89–5.84]	< 0.001
Number of children						
1–3	403	147 (36.5)	256 (63.5)	< 0.001	1	—
4–6	179	122 (68.6)	57 (31.4)*		3.73 [2.52–5.51]	< 0.001
7–10	101	29 (28.7)	72 (71.3)		0.70 [0.43–1.14]	0.150

Table 1 shows the sociodemographic profile of this sample. It reveals a predominance of young individuals; the 18–28 age group accounted for 45.7% of the total sample, followed by the 29–39 age group (31.9%). The study population is predominantly female, at 81.9%.

In terms of education, more than half of the study participants had completed primary school (58.4%), while only 11.7% had attended higher education or college. As for marital status, married women were the most represented group (78.5%). In terms of socio-occupational profile, homemakers (34.6%) and female farmers (31.8%) constituted the main categories.

The geographic distribution within the city of Kisangani shows that the Losoko health zone (Lubunga Commune) was the most represented at 24.8%, followed by the Kilanga health zone (20.8%). Finally, nearly half of the participants (49.3%) had a family consisting of 1 to 3 children.

The bivariate analysis reveals that age, marital status, occupation, and commune of residence were strongly

associated with anemia ($p < 0.05$), whereas educational level was not significant. Logistic regression identified the following as the main determinants: working in commerce ($ORa = 4.19$) and agriculture ($ORa = 2.49$), residing in Lubunga ($ORa = 5.80$), having 4 to 6 children ($ORa = 3.73$), and being aged 29–39 ($ORa = 2.41$).

Statistically significant variables ($p < 0.05$): Occupation, municipality of residence, and number of children show a highly significant association with anemia in the bivariate chi-square test ($p < 0.001$).

Major risk factors (multivariate analysis):

Economic sector: People working in commerce ($ORa = 4.19$) and female farmers ($ORa = 2.49$) have a significantly higher risk of anemia compared to civil servants.

Geographic area: Residents of Lubunga ($ORa = 5.80$) and Kabondo ($ORa = 3.55$) are at the highest risk compared to those in Makiso. Family size: Having 4 to 6 children increases the risk of anemia by a factor of 3.73 compared to households with 1 to 3 children.

3.2 Identification of Medicinal Plants

3.2.1 Knowledge of the Use of Herbs to Treat Anemia

Table 2

Knowledge of the Use of Herbal Remedies for Anemia

Knowledge of herbal treatments for anemia	Number of Households	Percentage
Yes	298	43.7
No	385	56.3
Total	683	100

Table 2 shows that the majority of study participants, 56.3% ($n = 385$), were unaware of the use of herbal treatments for anemia, compared with 43.7% ($n = 298$) who were aware of it. This difference is statistically significant, indicating a predominance of non-use of traditional herbal treatments for managing this condition (highly significant p -value: $p = 0.0008$).

3.3 Clinical Signs Motivating the Use of Herbal Treatment for Anemia

Table 3

Distribution of clinical syndromes or combinations of symptoms that lead study participants to initiate traditional herbal treatment

Signs Leading to the Use of Herbal Medicine	Number of subjects	Percentage (%)
Paleness, fatigue, fever	84	28.3
Prolonged fever, loss of appetite, difficulty breathing	52	17.4
Seizures, weight loss, vomiting	46	15.4
Fever, weight loss, difficulty breathing	42	14.1
Paleness, difficulty breathing, vomiting	34	11.4
Prolonged fever, seizures, difficulty breathing	22	7.4
Weight loss, difficulty breathing, pallor	18	6.0
Total	298	100.0

The data in Table 3 show that the combination “Paleness, fatigue, fever” was by far the most common, accounting for 28.3%, while combinations involving “breathing difficulties” (dyspnea) and “prolonged fever” together accounted for a significant portion of the reasons, at 17.4%. Finally, signs such as “seizures” or weight loss (7.4% and 15.4%, respectively) were observed. Statistical analysis revealed a significant difference ($p < 0.001$) in the perception of clinical signs leading to herbal treatment.

3.4 Number of Medicinal Plants Known to the Study Participants

The table below shows the number of medicinal plants used to treat anemia that the study participants who practice herbal medicine reported knowing.

Table 4

Distribution of study participants by number of medicinal plants known

Number of plants known	Number of participants	Percentage (%)
1 to 4 plants	166	55.7
5 to 8 plants	83	27.9
9 to 12 plants	49	16.4
Total	298	100.0

Table 4 shows that more than half of the study participants knew between 1 and 4 plants (55.7%), while 44.3% of the study participants knew between 5 and 12 plants.

Statistical analysis reveals a highly significant difference ($p < 0.001$) in the participants’ theoretical knowledge. Practitioners do not all possess the same level of expertise in phytotherapy.

3.5 Plant Parts Used for the Treatment of Anemia

The following table shows the distribution of the different plant parts used by the study subjects.

Table 5

Distribution of study participants by plant parts used

Plant part used	Number of Subjects	Percentage (%)
Leaves	139	46.6
Bark	74	24.8
Flowers	42	14.1
Nuts and seeds	23	7.8
Fruits and Juices	20	6.7
Total	298	100.0

From Table 5, we can observe a predominance of leaves (46.6%), with nearly half of the remedies using leaves. Meanwhile, the significant use of bark (24.8%) was incorporated into nearly a quarter of the remedies. Secondary plant parts—flowers (14.1%), kernels/seeds (7.8%), and fruits (6.7%)—trailed behind. Statistical analysis reveals a significant and substantial difference ($p < 0.001$) in the selection of plant parts.

3.6 Ethnobotanical Identification of Plants Used to Treat Anemia

The following table lists the plant species used by the study participants, grouped according to the anatomical part primarily utilized.

Table 6

Distribution of study participants regarding the ethnobotanical identification of plants used to treat anemia

Categories and plant species identified	Number of Subjects	Percentage (%)
LEAVES <i>Amaranthus</i> spp. (Amaranths), <i>Aspilia africana</i> , <i>Asparagus africanus</i> , <i>Musa</i> spp. (Banana), <i>Ageratum conyzoides</i> , Coffee plant, <i>Cucurbita maxima</i> , <i>Tetradenia riparia</i> , <i>Manihot esculenta</i> (Cassava), <i>Mangifera indica</i> (Mango), <i>Moringa oleifera</i> , <i>Hibiscus sabdariffa</i> (Roselle), <i>Carica papaya</i> (Papaya), <i>Ipomoea batatas</i> (Sweet potato), <i>Tectona grandis</i> (Teak), Tea plant.	132	44.2
BARKS <i>Artocarpus heterophyllus</i> (Breadfruit tree), <i>Persea americana</i> (Avocado tree), <i>Cola nitida</i> (Cola tree), <i>Artocarpus altilis</i> (Jackfruit tree), <i>Myrianthus arboreus</i> , <i>Musanga cecropioides</i> (Parasol tree), <i>Dacryodes edulis</i> (Safou tree), <i>Treculia africana</i> .	74	24.8
FLOWERS <i>Cosmos sulphureus</i> (Sulfur Cosmos).	42	14.1
FRUITS AND JUICES Pineapple, Lemon, Maracudja (Passion fruit), Tomatoes.	27	9.1
NUTS AND SEEDS <i>Persea americana</i> (avocado pit), spinach, soy.	23	7.8
Total	298	100.0

Analysis of the data in Table 6 shows that leaves (44.2%) ranked first among the categories and species of plants surveyed. Meanwhile, bark and forest species (24.8%) ranked second—a significant proportion—while fruits and juices (9.1%) ranked second to last.

3.7 Sources of Antianemic Medicinal Plants

The table below shows the social sources from which the study participants obtained medicinal plants to treat anemia.

Table 7

Distribution of Study Participants by Source of Antianemic Medicinal Plants

Sources of supply	Number of Subjects)	Percentage (%)
Forest	99	33.3
Market	83	27.8
Around the House	56	18.8
Grandmother	21	7.0
Church brothers and sisters	18	6.0
Neighbors	16	5.4
Traditional practitioners	5	1.7
Total	298	100.0

From Table 7, we observe that one-third of participants gather their remedies directly from the forest (33.3%), Purchasing at the market is the second-largest source at 27.8%; nearly one in five study participants used plants found around the home (18.8%), while social support networks play a significant role through the family unit (Grandmother: 7.0%), religious networks (Church brothers

and sisters: 6.0%), and neighborhood social networks (neighbors: 5.4%), with a combined total of 20.1%. Surprisingly, direct recourse to licensed or recognized traditional healers is negligible (traditional healers: 1.7%). Statistical analysis reveals a highly significant asymmetry ($p < 0.001$) in the supply channels.

3.8 Daily Dosage Schedule of Herbal Remedies

The table below shows the daily frequency of intake of traditional antianemic preparations by study participants.

Table 8

Distribution of study participants by daily administration frequency (dosage) of herbal remedies

Number of doses per day	Number of subjects	Percentage (%)
Once a day	76	25.5
Twice a day	137	46.0
3 times a day	48	16.1
As needed (after the first or second dose)	37	12.4
Total	298	100.0

Analysis of this table 8 shows that nearly half of the study participants took the medication twice a day (usually in the morning and evening) (46.0%), and the pattern of three daily doses (16.1%) often aligns with the classic model of three doses (16.1%) and a single dose (25.5%). The statement “As needed after the first or second dose” (12.4%) reflects the experience typical of traditional self-medication. Statistical analysis reveals a highly significant difference ($p < 0.001$) in administration schedules.

3.9 Formulation Methods (Instructions for Use) of Antianemic Remedies

The table below presents the different preparation methods used by the study participants.

Table 9

Distribution of study participants according to galenic preparation methods (instructions for use) of antianemic remedies

Preparation/Administration Method	Number of Subjects	Percentage (%)
Decoction	141	47.3
Infusion	74	24.8
Powder	38	12.8
For washing or applying to the body	34	11.4
Pure juice	11	3.7
Total	298	100.0

Table 9 shows that decoctions (47.3%) were the most commonly used form, followed by infusions (24.8%), powders (12.8%), topical application (11.4%), and pure juice (3.7%). Statistical analysis reveals a highly significant ($p < 0.001$) heterogeneity in the choice of dosage forms.

3.10 Reasons for Using Herbal Treatments for Anemia

The table below presents the motivating factors and major determinants that lead study participants to use herbal medicine.

Table 10

Distribution of study participants according to reasons for using herbal treatments for anemia

Reasons for Using Herbal Medicine	Number of Subjects	Percentage (%)
Low cost, readily available, and effective	128	43.0
Readily available, effective	111	37.3
Difficulty accessing the hospital / high cost	33	11.0
Cultural, religious, and family influences	26	8.7
Total	298	100.0

A review of this table 10 shows that the vast majority of study participants justified their use of plants based on rational criteria for daily management. The combination of “Low cost, readily available, and effective” (43.0%) and “Readily available and effective” (37.3%) accounts for a cumulative “Accessibility-Cost-Effectiveness” total of

80.3%. Cultural, religious, and family influences accounted for the smallest proportion (8.7%).

Statistical analysis reveals a highly significant asymmetry ($p < 0.001$) in the motivating factors. The choice of herbal medicine is not random; it is dictated by a combination of immediate practical benefits (accessibility, cost) and constraints related to the modern healthcare system.

3.11 Practitioners' Suggestions for Improving Herbal Therapy for Anemia

Table below summarizes the recommendations made by the study participants.

Table 11

Distribution of study participants according to practitioners' suggestions for improving herbal therapy for anemia

Practitioners' Suggestions	Number of Participants	Percentage (%)
Introduce herbal treatment in hospitals and train healthcare staff	125	42.0
Train healthcare staff and build the capacity of traditional practitioners	114	38.3
Organize targeted awareness campaigns on the practice for the general public	33	11.0
Strengthen the capacity of traditional healers only	26	8.7
Total	298	100.0

Regarding suggestions for topics to be studied, as mentioned in Table 11, the official introduction of validated anti-anemic plants within hospital facilities, coupled with training for healthcare personnel, accounts for 42.0%. Strengthening cross-disciplinary skills—“Training healthcare staff and strengthening traditional practitioners”—accounted for a total of 47.0% (38.3% and 8.7%, respectively), along with the need for community health education through “targeted awareness campaigns for the population” (11.0%).

Statistical analysis reveals a significant convergence of opinions ($p < 0.001$).

4. Discussion of Results

4.1 Sociodemographic Characteristics of the Study Participants

Regarding the sociodemographic profile, we observed a predominance of young participants; the 18–28 age group accounted for 45.7% of the total sample, while more than half of the study participants had a primary school education (58.4%), and the status of married women was the most common (78.5%); housewives accounted for a high proportion at 34.6%. The geographic distribution within the city of Kisangani shows that the Losoko health zone

was the most represented at 24.8%. Finally, nearly half of the participants (49.3%) had a household consisting of 1 to 3 children. The results of our study show a predominance of young participants (ages 18–28), mostly married women, often homemakers, with a primary school education. This sociodemographic profile is particularly vulnerable to anemia due to increased nutritional needs related to pregnancy, family responsibilities, and limited access to modern healthcare. This observation aligns with that of Kouadio et al. (2019), who emphasize that women of childbearing age, especially in rural or urban-rural areas, are most at risk for iron deficiency.

Our results, which highlight a high proportion of homemakers (34.6%), are consistent with the findings of Traoré et al. (2020) and Akindes et al. (2016), who, in their study on “Anemia in Côte d’Ivoire: The Value of a Social Approach,” found that 63.5% of the study participants were at the secondary education level. Similarly, Dembele (2019) found 59.1% in the same category, indicating that married women rely more heavily on plants—particularly

decoctions of local leaves (amaranth, cassava)—to treat anemia. This practice is reinforced by the availability of plants in local markets in Kisangani; since Kisangani is located in the equatorial forest—based on its natural geographical position—hibiscus (bissap) and leafy vegetables are readily available and inexpensive.

We know that anemia is multifactorial; it can be linked not only to nutritional deficiencies but also to chronic infections such as malaria and parasitic infections. Thus, while plants are a valuable resource, they must be integrated into a comprehensive approach that includes infection prevention and iron supplementation.

We note that the high proportion of young married women and homemakers in our study reflects a population that is predominantly at home and has children who are at risk of developing anemia, for which the use of medicinal plants is a traditional strategy to treat this condition. Research by other authors confirms the relevance of these practices, while emphasizing the need to combine them with modern medical interventions for effective management.

4.2 Awareness of Herbal Treatment for Anemia

Analysis of the data reveals that the majority of study participants—56.3%—were unaware of the practice of treating anemia with plants, compared to 43.7% who were aware of it.

Several authors have reported similar findings. Traoré et al. (2020) showed that, despite the availability of medicinal plants, a significant portion of the population remains poorly informed about their therapeutic uses, particularly for anemia. Similarly, Diallo et al. (2015) emphasized that a lack of knowledge about the nutritional and medicinal properties of certain plants limits their use in the prevention and treatment of iron-deficiency anemia.

Conversely, Nacoulma (1996) demonstrated that in certain rural communities in Burkina Faso, knowledge of and use of plants such as stinging nettle and hibiscus are widespread, serving as a first-line treatment for anemia. This difference highlights the importance of the sociocultural and educational context in the transmission of traditional knowledge.

The limited knowledge among the population of Kisangani regarding herbal treatments observed in our study underscores the city's cosmopolitan nature, as it comprises both urban and urban-rural districts, which necessitates strengthening awareness and health education campaigns to promote the judicious use of local resources, on the one hand.

On the other hand, the prevalence of non-use could be explained by a shift toward modern healthcare or by insufficient dissemination of knowledge about medicinal plants. This situation is often linked to low levels of

education, as observed in our study, where more than half of the participants had only a primary school education, which limits access to information on traditional health practices.

This finding is particularly interesting in a context where medicinal plants are often considered an accessible and culturally integrated alternative for managing common ailments.

4.3 Clinical Signs Motivating the Use of Herbal Treatment for Anemia

The data obtained from this study show that the clinical signs prompting the use of herbal treatment for anemia are dominated by the combination of “pallor, fatigue, and fever” (28.3%). The presence of combinations involving dyspnea and prolonged fever (17.4%) reflects a perception of the disease as more serious, leading patients to seek quick and accessible solutions. Finally, more severe symptoms such as seizures (7.4%) and weight loss (15.4%) were also observed, reinforcing the fact that anemia can progress to complicated forms.

These findings are consistent with those of Diallo et al. (2015), who showed that chronic fatigue and pallor are the main reasons for seeking traditional remedies in rural areas. Similarly, in Dembele's (2019) study, fever and chills were the most commonly reported symptoms, at 54.12% and 42.06%, respectively. Meanwhile, Traoré et al. (2020) reported that shortness of breath and prolonged fever are often interpreted as signs of severe anemia, prompting families to use decoctions of local plants rich in iron and vitamins.

In a study conducted in Burkina Faso, Nacoulma (1996) noted that people associate pallor and physical weakness with a blood deficiency, which justifies the use of plants such as hibiscus and stinging nettle to “restore blood.” In Yaoundé, Nguefack et al. (2017), in a study conducted at the Chantal Biya Foundation's Mother and Child Center, found that fever, asthenia, and pallor of the skin and mucous membranes were the most commonly observed symptoms; 100% of the cases in their study presented with these symptoms, and 57.02% of the patients had a fever.

These signs are often the primary reason for seeking medical care and frequently indicate severe or complicated anemia, requiring urgent medical attention. The fact that some study participants turn to herbal remedies in these situations demonstrates both their trust in traditional medicine and their lack of access to modern healthcare.

4.4 Number of Medicinal Plants Known to Practitioners

An analysis of the data shows that more than half of the study participants (55.7%) knew of between 1 and 4 medicinal plants used to treat anemia, while 44.3% knew of between 5 and 12.

In certain rural populations of Burkina Faso, Nacoulma (1996) reported that study participants could identify up to ten plants used to treat anemia, reflecting a more deeply rooted tradition of herbal medicine.

The disparity observed in our study can be explained by several factors: low educational attainment (mostly primary school), the predominance of housewives, and geographic location (the Losoko health zone). These factors influence access to information and the transmission of traditional knowledge.

Thus, the variation in the number of plants known to practitioners illustrates an inequality in the mastery of herbal medicine. While some possess relatively extensive knowledge, others are limited to just a few species, underscoring the need for scientific outreach and guidance on traditional practices to maximize their contribution to the prevention of anemia. In other words, not everyone has the same background for practicing herbal medicine, which can affect the quality and effectiveness of traditional treatments.

4.5 Plant Parts Used to Treat Anemia

The results show that leaves (46.6%) are the most commonly used plant parts in the herbal treatment of anemia, followed by bark (24.8%), while secondary plant parts such as flowers (14.1%), seeds/kernels (7.8%), and fruits (6.7%) are used less frequently.

These results are consistent with the observations of Nacoulma (1996), who reports that leaves are the most commonly used part in traditional African medicine, due to their availability and high content of active ingredients (iron, vitamins, chlorophyll). They are commonly used to treat iron-deficiency anemia because they are easy to find and are often incorporated into the daily diet. The use of bark, although less common, is cited by Traoré et al. (2012), who note its use in decoctions to “fortify the blood” and boost essential nutrients, particularly in Mali.

The use of flowers, seeds, and fruits remains less common, but it is not negligible. Seeds and pits, although used less frequently, are sometimes incorporated into local preparations to enhance the therapeutic effect.

Thus, the selection of plant parts used in the treatment of anemia influences the preference for leaves—a finding confirmed by the literature—but also reflects a diversity of practices that warrants further investigation and analysis to maximize their efficacy and safety. Finally, it should be noted that the predominance of leaves may also be explained by the fact that they are easy to find and prepare, unlike bark or seeds, which require more complicated methods.

4.6 Identification of Plants Used to Treat Anemia

A systematic analysis of the plants used to treat anemia in our study reveals a predominance of leaves (44.2%),

followed by bark and forest species (24.8%), while fruits and juices (9.1%) play a more marginal role.

These results corroborate the observations of Martinaz (2017), who reports that the leaves of *Tetradenia riparia*, *Manihot esculenta* (cassava), *Mangifera indica* (mango), *Moringa oleifera*, *Hibiscus sabdariffa* (roselle), and *Carica papaya* (papaya) are widely used for the prevention and treatment of iron-deficiency anemia, due to their inclusion in the daily diet. The use of bark, although less common, is described in decoctions intended to “fortify the blood.”

We believe that the use of medicinal plants represents a common therapeutic alternative and that certain plant species are effective in the management of anemia. The leaves are rich in iron and vitamins, promoting the regeneration of red blood cells, as are *Tetradenia riparia* and *Manihot esculenta* (cassava), which provide not only iron but also vitamin C, thereby improving the absorption of dietary iron.

However, the empirical use of bark and other secondary plant parts can lead to overdoses and risks of toxicity.

In summary, the ethnobotanical identification of plants used to treat anemia reveals a marked preference for leaves, as confirmed by the literature, but also a diversity of uses that warrants further analysis to maximize efficacy.

4.7 Sources of Medicinal Plants for Treating Anemia

The analyzed data reveal that the main sources of medicinal plants are the forest (33.3%) and the market (27.8%), followed by plants found around the home (18.8%), while social networks (family, church, neighbors) together account for 20.1%.

These results are consistent with those of Traoré et al. (2020), who showed that the forest is a primary source of medicinal plants in West Africa, due to its rich biodiversity and the transmission of traditional knowledge. Similarly, Nacoulma (1996) emphasizes that local markets play a central role in the distribution of medicinal plants, enabling urban and peri-urban populations to access traditional remedies without having to travel to the forest.

The role of social support networks (family, church, neighbors) is particularly noteworthy. As noted by the WHO (2021), the transmission of traditional knowledge often relies on community structures that play a key role in promoting herbal medicine practices. This social dynamic strengthens community cohesion and facilitates access to remedies, even in the absence of financial resources.

The various sources of medicinal plants reflect a combination of ecological (forests, gardens), economic (markets), and social (support networks) factors. This diversity is a source of richness, but it also underscores the need to promote these practices to ensure their effectiveness. These medicinal plants are generally available in urban

markets, particularly in Kisangani, as well as in rural and outlying areas, which attests to the deep-rooted place of traditional medicine in local practices.

4.8 Daily Dosage Schedule for Herbal Remedies

The results regarding the daily administration schedule of herbal remedies show that taking the remedy twice a day (46.0%)—usually in the morning and evening—is the most common practice. This is followed by a single daily dose (25.5%) and the traditional schedule of three daily doses (16.1%). Finally, the instruction “as needed after the first or second dose” accounted for 12.4%.

These data are consistent with the observations of Diallo et al. (2015), who showed that the dosing of herbal remedies for anemia varies according to cultural practices and practitioners' experience, rather than on the basis of standardized scientific guidelines.

Thus, the diversity of administration schedules observed in our study reflects a rich but non-standardized traditional practice. It underscores the need for scientific guidance to define appropriate, safe, and effective dosages, while respecting local knowledge.

The frequency of taking the products depends on the patient's health status. Nelson (2007) recommends, for preventive purposes, three doses taken in quick succession at intervals of 3 to 5 days, followed by a maintenance dose every 3 to 6 months, with the first beneficial effects generally appearing after two to three sessions. Furthermore, Oyono S. (2001) notes that anti-anemic treatments are also used to stimulate certain physiological functions in children, such as increasing hemoglobin levels or boosting immunity. However, excessive use can lead to adverse effects, particularly in cases of overdose or improper preparation of the substances. It is therefore crucial to educate families about the potential risks and the importance of sensible, well-informed use.

4.9 Methods of Pharmaceutical Preparation (Instructions for Use) of Antianemic Remedies

The data collected show that decoctions are the most commonly used method (47.3%) for preparing remedies for anemia, followed by infusions (24.8%), powders (12.8%), topical applications (11.4%), and pure juice (3.7%). This diversity is statistically significant ($p < 0.001$) and reflects an adaptation of traditional practices to local realities.

According to Creapharma (2020), decoctions are particularly suitable for the hard parts of plants (roots, bark, seeds), as prolonged boiling promotes the extraction of active ingredients. Similarly, Tradition Nature (2019) emphasizes that this method optimizes the bioavailability of water-soluble and heat-stable compounds, which explains its frequent use in treatments for anemia.

The infusion, the second most commonly used method, is better suited for delicate parts such as leaves and flowers. It helps preserve heat-sensitive volatile molecules, particularly essential oils. Creapharma (2020) notes that the infusion must be consumed quickly (within 24 hours), which limits its long-term use but makes it an effective method for short-term treatments.

The prevalence of decoctions in treatments for anemia stems from their effectiveness in extracting active compounds from the hard parts of plants. Infusions are used in combination with other plant parts to enhance their effectiveness, while powders and juices offer alternatives and are used for infants and newborns as indicated.

4.10 Reasons for Treating Anemia with Herbs

The majority of study participants surveyed (80.3%) justified their choice based on the combination of “accessibility, cost, and effectiveness,” which reflects a practical, everyday approach to health management. According to Diallo et al. (2012), rural populations prefer herbal remedies because they are accessible without significant expense and do not require sophisticated medical facilities.

The perceived effectiveness of plants is another key factor. Surveys conducted by Giday et al. (2009) in Ethiopia show that patients associate the use of plants with striking results, reinforcing their confidence in these practices. This perception of effectiveness, combined with immediate availability, explains the high level of adherence observed in your study.

Thus, the use of plants to treat anemia is not random: it is driven by a combination of immediate benefits (accessibility, cost, effectiveness) and by the constraints of the modern healthcare system, which is often characterized by stock shortages, high costs, or limited health coverage.

4.11 Suggestion

The suggestions made by practitioners to improve herbal therapy for anemia reveal a clear desire to integrate these practices into a more structured and recognized framework. The most common proposal (42.0%) concerns the official introduction of validated anti-anemic herbs within hospital settings, accompanied by training for healthcare personnel. This approach reflects a call for the institutionalization of herbal medicine to ensure the quality, safety, and efficacy of treatments. Several authors, such as the WHO (2013), emphasize the importance of integrating traditional medicine into modern health care systems, noting that this helps build patient trust and improve health care coverage. This convergence reflects a mutual recognition of knowledge: on the one hand, the need for healthcare professionals to acquire knowledge about medicinal plants; on the other, the importance of promoting and regulating the practices of traditional healers.

4.12 Limitations of the Study

Like any research, this study has certain limitations that should be highlighted to better contextualize the scope of the results:

1. The sampling method used was non-probability-based, which does not guarantee perfect representativeness of the entire population of Kisangani. The results therefore reflect the perceptions of the selected participants rather than those of the entire community.
2. The descriptive and cross-sectional nature of the study limits the ability to establish causal relationships between sociodemographic determinants and the use of medicinal plants.
3. The information collected is based on parents' reports, which leaves room for recall bias or an overestimation of the plants' efficacy.
4. The study did not conduct pharmacological or clinical validation of the identified plants. The results are therefore limited to an ethnobotanical inventory and an analysis of social determinants, without confirmation of actual therapeutic efficacy.

4.13 Généralisabilité

Les résultats de cette étude, obtenus auprès de 298 parents résidant dans les zones périphériques de Kisangani, reflètent principalement les réalités locales de la prise en charge de l'anémie infantile. En raison du caractère transversal et descriptif de la méthodologie, ainsi que du recours à un échantillonnage non probabiliste, la validité externe demeure limitée. Toutefois, ces résultats peuvent être transférés à des contextes similaires en République Démocratique du Congo, notamment dans les zones urbaines et urbaines rurales où coexistent médecine moderne et pratiques traditionnelles. Ils constituent une base utile pour des recherches comparatives dans d'autres provinces ou pays africains confrontés à des problématiques semblables.

5. Conclusion

Cette étude a mis en évidence que les jeunes femmes mariées, souvent au foyer et faiblement instruites, représentent une population particulièrement vulnérable à l'anémie. Le recours aux plantes médicinales est motivé par leur accessibilité, leur faible coût et leur efficacité perçue, bien que les connaissances sur ces pratiques demeurent inégales et non standardisées. Les feuilles, riches en fer et vitamines, sont les parties les plus utilisées, confirmant leur rôle central dans la prévention et le traitement de l'anémie. Ces résultats soulignent l'importance d'intégrer les savoirs traditionnels dans une approche globale de lutte contre l'anémie, tout en tenant compte des limites méthodologiques de l'étude.

6. Recommandations

1. Encourager l'éducation sanitaire et la sensibilisation communautaire afin d'améliorer la connaissance des propriétés nutritionnelles et médicinales des plantes locales.
2. Faire avancer des recherches pharmacologiques et cliniques pour valider scientifiquement l'efficacité et la sécurité des plantes identifiées.
3. Valoriser l'intégration des plantes médicinales validées dans les structures hospitalières, accompagnée de la formation du personnel de santé.
4. Impulser des programmes communautaires encadrés pour soutenir la transmission des savoirs traditionnels et réduire les risques liés aux surdosages ou aux préparations inadéquates.
5. Étendre les études à des échantillons plus larges et diversifiés afin de renforcer la validité externe et permettre une meilleure généralisation des résultats.

Conflit d'intérêts

Aucun des auteurs n'a reçu ni entretenu de liens personnels, financiers ou professionnels avec les répondants. Nous déclarons donc n'avoir aucun conflit d'intérêts.

Data availability

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

Competing interests

The authors declared that no competing interests exist.

Author contributions

D.O.F: Conceptualization, Formal Analysis, Project Management, Writing - Original Draft; **O.O.M.C:** Methodology, Data Curation, Writing-Review and Editing; **M.B.B:** Methodology, Data Curation, Writing-Review and Editing; **E.K.M:** Writing-Review and Editing. **K.T.N.N:** Methodology and Writing-Review & Editing. **M.N.C:** Methodology, supervision, writing-review, and editing; **A.M.J.M:** Methodology, data curation and analysis, supervision, and writing-review & editing

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Ethics approval and consent to participate

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, and the research protocol was approved by the Bioethics Committee of ISTM KINSHASA, number 0031/CBE/ISTM/KIN/RDC/PMBBL/2023, dated 29/11/2023.

Written consent has been obtained from all participants.

Consent to participate

All participants provided written consents

Consent for publication

Not applicable

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