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Impact of hematological and biochemical imbalances on early aging in adults aged 50 and above in five localities of Western Cameroon

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Abstract

Background: Aging is accompanied by biological changes that may accelerate the onset of diseases. In sub-Saharan Africa, elderly populations are particularly vulnerable to hematological and biochemical imbalances, which can serve as markers of early aging. This study examines the interactions between hemoglobin, creatine kinase (CK), and lymphocytes in elderly individuals from five localities in Western Cameroon (Bafang, Bafoussam, Baham, Bandjoun, and Dschang).

Objective: To assess the association between anemia, hyperCKemia, hypoCKemia, and early aging in this population, taking into account sex-and locality-based variations, and to analyze the impact of these imbalances on the health of the elderly.

Methods: A cross-sectional study was conducted on 768 participants aged 50 and above. Hemoglobin, CK, and lymphocyte levels were measured. Statistical analyses, including the Chi-square test and correlation analyses, were performed to identify associations between these biological parameters and demographic factors.

Results: The study highlights a significant prevalence of anemia, hyperCKemia, and hypoCKemia, with notable differences based on sex and locality. A strong correlation was observed between CK and hemoglobin levels, suggesting an interaction between muscle metabolism and hematological status, exacerbated by early aging.

Conclusion: These findings underscore the need for targeted medical monitoring of elderly populations to prevent complications related to hematological and biochemical imbalances. Early management of these anomalies could help mitigate the effects of early aging, particularly in resource-limited settings.

Keywords: Early aging, anemia, creatine kinase, lymphocytes, biomarkers, Cameroon

Introduction

Aging is accompanied by various physiological changes, including alterations in hematological and biochemical parameters, which may predispose individuals to chronic conditions such as anemia and metabolic imbalances (Ferrucci *et al.*, 2020) [3]. In sub-Saharan Africa, where healthcare access remains limited, these imbalances are often underdiagnosed, exacerbating the vulnerability of older populations (Ataklte *et al.*, 2015) [1]. Hemoglobin levels play a crucial role in oxygen transport, and deviations from normal values such as anemia and erythrocytosis—are associated with adverse health outcomes, including increased frailty and cardiovascular risks (Penninx *et al.*, 2016) [6]. Similarly, creatine kinase (CK) is an important biomarker of muscle metabolism, and its variations (hyperCKemia and hypoCKemia) may reflect underlying muscle degeneration, metabolic disorders, or inflammatory processes (Nagasawa *et al.*, 2019) [5]. Previous studies have highlighted the relationship between CK levels and hematological profiles, particularly in aging populations (Cesari *et al.*, 2014) [2].

However, the interplay between hemoglobin and CK levels in sub-Saharan populations remains poorly documented. This study aims to explore the association between anemia, CK variations, and aging in five localities of the West Region of Cameroon, taking into account geographic and demographic differences.

By investigating these interactions, we seek to provide insights into the biological mechanisms contributing to early aging and potential risk factors for age-related diseases.

Methodology

Study Design

This study was conducted in five localities: Bafang, Bafoussam, Baham, Bandjoun, and Dschang. A total of 768 participants aged 50 years and older were recruited and categorized into four age groups (50-59, 60-69, 70-79, and ≥ 80 years), as well as by sex.

Data Collection

Blood samples were collected to measure hemoglobin levels, creatine kinase (CK) concentrations, and lymphocyte counts. Hemoglobin status was classified into three categories: anemia, normal, and erythrocytosis. CK levels were categorized as hypoCKemia, normal, and hyperCKemia.

Statistical Analysis

Data analysis was conducted using SPSS and XLSTAT software. The following analytical approaches were employed

1. Pearson Correlation Tests

Associations between electrolyte levels, age, gender, and localities were assessed using Pearson correlation coefficients. A significance threshold of $p < 0.05$ was applied.

2. Cross-Tabulation Analysis

Dynamic cross-tabulation tables were used to explore associations between categorical variables, such as

hemoglobin levels, CK concentrations, and demographic variables, age groups, gender, and geographical localities.

These combined methods ensured a robust and comprehensive analysis of the relationships between the measured parameters and the demographic characteristics of the study population.

Résultats

Study Population Characteristics

A total of 768 participants were included in the study (451 women, 317 men), with a female dominance of 58.7%.

Geographical Distribution

- **Bafang:** High female participation, particularly in the 50-59 age group.
- **Bafoussam:** Balanced age distribution with a slight female predominance.
- **Baham:** Strong presence in the 50-59 age group.
- **Bandjoun:** Female dominance, especially among those aged 60-69 years.
- **Dschang:** High participation, notably among older women.

Prevalence Trends

- Women represented the majority of participants across all localities.
- Age distribution varied significantly depending on the region.

Table 1: Distribution of the Study Population by Sex, Age, and Locality

Localities	Villages	50-59	60-69	70-79	≥ 80	Total
		F	M	F	M	F
Bafang	Bana	15	4	22	8	10
	Banka	12	21	8	17	2
Bafoussam	Kamkop	20	15	14	12	11
	Tamdja	5	13	12	12	4
Baham	Demgo	25	17	11	6	7
	Medjo	18	9	24	8	6
Bandjoun	Semtôh	8	17	6	19	8
	Tsélâh	17	13	12	14	9
Dschang	Fotetsa	25	7	23	5	12
	Johnny Baleng	22	5	24	5	23

Total: 768 participants (F: 451 [58.7%]; M: 317 [41.3%])

F: Female; M: Male

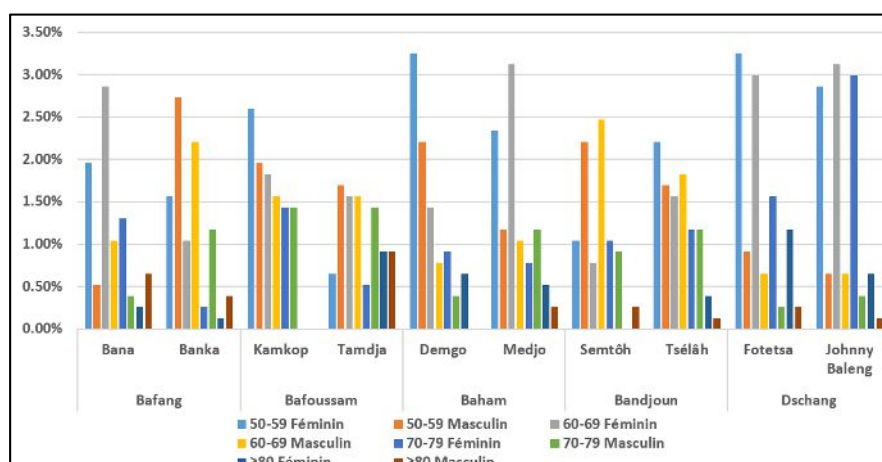


Fig 1: Percentage Distribution of the Population by Sex and Age Group in Various Localities of Western Cameroon.

Table 2 presents the distribution of hemoglobin categories (anemia, normal, and erythrocytosis) across the five study localities: Bafang, Bafoussam, Baham, Bandjoun, and Dschang.

Anemia

HypoCKemia

- Bafang has the highest prevalence of anemia in this category, with 13 cases, representing 37.1% of this subcategory in the locality.
- Bafoussam and Baham show lower proportions, with 4.6% and 0%, respectively, in this subcategory.
- Bandjoun and Dschang exhibit slightly higher anemia rates, with 16% and 7.7%, respectively.

Normal CK

- Bafoussam records the highest anemia rate in this category, with 43 cases (58.6% of individuals in this subcategory in the locality).
- Baham follows with 28.9% (29 cases), while Dschang and Bandjoun show lower proportions, with 21.9% (18 cases) and 14.1% (19 cases), respectively.

HyperCKemia

- In this category, anemia rates are moderate, with cases mainly distributed in Bafoussam (20.6%, or 13 cases) and Baham (13.6%, or 9 cases).
- Bafang also presents a few cases (15.9%, or 10 cases), while the other localities report lower rates.

Normal Hemoglobin Levels

HypoCKemia

- Normal hemoglobin levels are predominant in Dschang (51.5%, or 80 cases) and Bandjoun (53.6%, or 56 cases), indicating better hemoglobin regulation in these populations.
- Bafang also shows a notable rate of 51.5%, highlighting a balanced proportion of normal cases in the hypoCKemia category.

Normal CK

- Dschang records the highest rate of normal hemoglobin cases in this category, with 54.4% (87 cases).
- Baham also has a high proportion, with 76% (74 cases), while the other localities show lower but significant proportions.

HyperCKemia

Dschang (40%, or 8 cases) and Baham (45%, or 22 cases) continue to show a better distribution of normal hemoglobin cases in this subcategory.

Erythrocytosis

HypoCKemia

Erythrocytosis cases remain rare, but Dschang and Bafang show the highest rates in this subcategory, with 10.3% and 9.5%, respectively.

Normal CK

Erythrocytosis cases in this category are also low, with a low prevalence observed in Bafang and Dschang, each accounting for approximately 2.3% of cases in this subcategory.

HyperCKemia

In this category, erythrocytosis is nearly absent, indicating a weak association between hyperCKemia and erythrocytosis in the studied populations.

This analysis shows that anemia rates vary significantly based on CK status, age, and locality, with higher prevalence observed among individuals with normal CK levels. Normal hemoglobin cases are more evenly distributed in the populations of Dschang and Baham, particularly in the hypoCKemia and normal CK categories. Finally, erythrocytosis remains rare, especially in the normal CK and hyperCKemia categories, suggesting that this condition is less influenced by CK variations in these localities.

Table 2 : Hemoglobin Levels in the Study Localities Based on Creatine Kinase Levels and Age.

Taux d'hémoglobine	Localités	HypoCKémie				Normale				HyperCKémie				Total général
		50-59	60-69	70-79	≥80	50-59	60-69	70-79	≥80	50-59	60-69	70-79	≥80	
Anémie	Bafang	5	3	3	2	7	4	2	3	1	4	1	0	35
	Bafoussam	1	1	0	0	22	16	15	5	4	7	2	2	75
	Baham	0	0	0	0	10	10	10	5	4	4	1	0	44
	Bandjoun	4	6	6	0	2	4	2	1	2	3	0	0	30
	Dschang	3	1	1	2	6	7	2	3	0	2	0	1	28
Normale	Bafang	17	23	10	4	3	12	2	2	9	5	4	0	91
	Bafoussam	1	1	2	0	13	16	9	7	10	6	5	0	70
	Baham	2	1	0	0	30	22	10	3	15	7	4	3	97
	Bandjoun	25	16	12	0	14	12	6	3	5	6	4	2	105
	Dschang	30	24	18	8	8	12	10	3	6	6	2	0	127
Erythrocytose	Bafang	4	3	2	0	4	1	0	0	2	0	0	0	16
	Bafoussam	0	1	1	0	2	2	1	0	0	0	2	0	9
	Baham	0	0	0	0	4	3	0	0	4	2	0	0	13
	Bandjoun	0	3	2	0	2	0	1	0	1	1	0	0	10
	Dschang	5	5	5	0	1	0	1	0	0	0	1	0	18
Total général		97	88	62	16	128	121	71	35	63	53	26	8	768

Discussion

Our findings reveal a significant prevalence of anemia across the study population, with variations according to CK status and geographic location. The highest anemia rates

were observed among individuals with normal CK levels, while hypoCKemia and hyperCKemia were associated with slightly lower prevalence rates. These results align with previous research indicating that CK levels may serve as an

indirect marker of muscle mass and overall metabolic health in aging individuals (Nagasawa *et al.*, 2019; Cesari *et al.*, 2014) [5, 2].

Anemia and CK Variations

The predominance of anemia among individuals with normal CK levels may be explained by multiple factors, including nutritional deficiencies, chronic inflammation, and age-related hematopoietic decline. Studies have shown that anemia is prevalent in elderly populations, particularly in low-resource settings, where dietary iron, vitamin B12, and folate deficiencies contribute to its development (Guralnik *et al.*, 2004) [4]. Furthermore, anemia has been associated with increased frailty and reduced functional capacity, which could explain the lower prevalence of anemia in hypoCKemic individuals, as muscle degradation might be more advanced in this group (Ferrucci *et al.*, 2020) [3].

On the other hand, hyperCKemia has been linked to inflammatory processes and muscular stress, potentially contributing to altered erythropoiesis (Cesari *et al.*, 2014) [2]. The presence of anemia in individuals with elevated CK levels suggests a possible interplay between muscle metabolism and hematopoiesis, reinforcing the hypothesis that systemic inflammation may mediate these effects (Penninx *et al.*, 2016) [6].

Geographic Variations and Hemoglobin Regulation

The distribution of hemoglobin levels varied significantly across the five localities. Dschang and Baham exhibited better hemoglobin regulation, particularly in the hypoCKemia and normal CK groups, suggesting that environmental or lifestyle factors may influence these biomarkers. Prior research has highlighted the role of altitude, diet, and healthcare access in modulating hemoglobin levels (Ataklte *et al.*, 2015) [1]. The relatively lower anemia prevalence in these areas could be attributed to differences in dietary habits, access to healthcare, or genetic adaptations to altitude.

Conversely, Bafoussam had the highest anemia prevalence among individuals with normal CK levels, possibly indicating disparities in health conditions, nutritional intake, or chronic disease burden. Similar findings have been reported in studies analyzing urban-rural differences in anemia prevalence, where urban populations often experience higher rates of anemia due to lifestyle and dietary transitions (Guralnik *et al.*, 2004) [4].

Erythrocytosis and CK Status

Erythrocytosis was rare across all categories, particularly in the normal CK and hyperCKemia groups. This finding is consistent with previous studies suggesting that erythrocytosis is less prevalent in aging populations, as the physiological capacity for erythropoiesis declines with age (Nagasawa *et al.*, 2019) [5]. The low prevalence of erythrocytosis in hyperCKemic individuals further supports the notion that muscle metabolism alterations do not strongly influence red blood cell production in elderly populations.

Conclusion

These results highlight the complex interactions between hematological and biochemical parameters in aging populations. The observed geographic variations emphasize

the importance of local health policies and targeted interventions to address anemia and metabolic imbalances. Further longitudinal studies are needed to clarify the causal relationships between CK levels, anemia, and aging processes. The integration of nutritional and biochemical screening in geriatric care could improve early detection and management of these conditions, ultimately reducing the burden of age-related diseases in sub-Saharan Africa.

Recommendations and Perspectives

Based on these findings, several recommendations can be made to improve the management of anemia and metabolic imbalances in aging populations :

- 1. Regular Screening and Early Detection:** Implementing systematic screening programs for anemia and CK variations in elderly populations could help detect and manage these conditions early, reducing the risk of complications.
- 2. Nutritional Interventions :** Given the significant role of nutritional deficiencies in anemia, community-based programs promoting balanced diets rich in iron, vitamin B12, and folate should be encouraged.
- 3. Targeted Public Health Policies:** Regional disparities in anemia prevalence suggest the need for localized interventions, taking into account environmental, dietary, and healthcare access differences.
- 4. Further Research on CK and Aging:** Longitudinal studies exploring the causal relationships between CK variations, muscle function, and hematological parameters would provide deeper insights into the biological mechanisms underlying aging.
- 5. Integration of Geriatric Care Services :** Strengthening healthcare systems by integrating specialized geriatric services focused on hematological and metabolic health can improve the overall quality of life for elderly individuals.
- 6. Investigation of Inflammatory Pathways:** Given the potential role of inflammation in CK variations and anemia, further studies should examine the involvement of inflammatory markers such as C-reactive protein (CRP) and interleukin-6 (IL-6) in aging populations.

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Declarations

Ethical Approval and Consent to Participate: This study was approved by the Ethical Committee of the Bafoussam Regional Hospital. Written informed consent was obtained from all participants.

Availability of Data and Materials: The datasets used and analyzed during this study are available upon reasonable request from the corresponding author.

Competing Interests: The authors declare no competing interests.

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Authors' Contributions

- **Claude Alain NGNOTUE MBOBDA:** Study design, data collection, statistical analysis, manuscript drafting.
- **Dieudonné ADIOGO:** Supervision, methodology validation, manuscript review.
- **Arnold TIOFACK ZEBAZE, Rollin Mitterrand KAMGA, Christelle Laure MAGUIPA T, Cédric KENDINE VEPOWO:** Data analysis, manuscript editing, and critical revision.

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