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Analysis of the Calcium-Phosphorus Balance in Five Rural Localities in Cameroon According to Gender, Age, and Aging-Related Factors

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Abstract

Background: *Calcium and phosphorus metabolism is essential for bone health and many bodily functions. Aging, combined with often deficient diets in rural populations, can lead to significant metabolic imbalances.*

Objective: *This study aims to evaluate the variations in calcium-phosphorus balance according to gender and age in five rural localities of Cameroon: Bafang, Bafoussam, Baham, Bandjoun, and Dschang.*

Methods: *A total of 768 participants aged 50 and over were included. Serum phosphate and calcium levels were measured, and the results were analyzed according to age and gender.*

Results: *A significant prevalence of hypophosphatemia and hypocalcemia was observed, particularly among the elderly. These abnormalities are correlated with aging, specific diets, and the decline in kidney and bone function.*

Conclusion: *The study highlights the importance of regular medical follow-ups and nutritional supplementation programs to prevent complications related to these imbalances in this vulnerable population.*

Keywords: *Calcium-phosphorus balance, aging, hypophosphatemia, hypocalcemia, Cameroon*

Introduction

Calcium and phosphorus metabolism plays a crucial role in bone formation, muscle function, and nerve transmission. With age, hormonal changes, decreased intestinal absorption, and impaired kidney function influence these processes, increasing the risk of abnormalities such as hypocalcemia and hypophosphatemia **(Karsenty et *al.*, 2006).** In rural populations of developing countries, particularly in Cameroon, limited access to balanced diets and healthcare contributes to these imbalances (**Onyeka et *al.*, 2019**).

This study aims to explore the variations in calcium-phosphorus balance among individuals aged 50 and over in five rural localities of Cameroon, to better understand the factors associated with aging and bone health in this socio-economic context.

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Methodology

Study Population

The study was conducted in the localities of Bafang, Bafoussam, Baham, Bandjoun, and Dschang. A total of 768 participants aged 50 and over were grouped into four age categories (50-59, 60-69, 70-79, ≥80 years) and by gender (F for females, M for males).

Data Collection

Blood samples were taken to measure phosphate (phosphatemia) and calcium (calcemia) levels using standardized techniques. The results were classified into three categories: hypophosphatemia, normophosphatemia, and hyperphosphatemia, as well as hypocalcemia, normocalcemia, and hypercalcemia.

Data Analysis

Data were coded and analyzed using Epi Info 7.1.3.0, SPSS 18, Excel 2016, and Xlstat 2014 software. Correlation tests were performed to assess associations between biochemical imbalances and aging-related factors.

Results

The total population comprised 768 participants, with a majority of women (451, or 58.7%) compared to men (317, or 41.3%), reflecting global trends observed in other aging studies. The age distribution reveals an aging population, with a significant proportion of individuals aged 60 and above. Furthermore, the majority of participants fall within the age groups of 50-59 years (167 individuals) and 60-69 years (121 individuals), which is crucial for aging and health studies. The data were collected from several locations, including Bafang, Bafoussam, Baham, Bandjoun, and Dschang, with a higher concentration of elderly individuals in Dschang (85) and Bafoussam (83), while Bandjoun has a relatively lower proportion (67). These results highlight geographic variations in health characteristics and risk factors. They emphasize the importance of considering local disparities in the allocation of healthcare resources.

Table 1. Distribution of the Study Population by Sex, Age, and Localities

Localités	Villages	Tranches d'âge								Total
		50-59		60-69		70-79		≥80		
		F	M	F	M	F	M	F	M	
Bafang	Bana	15	4	22	8	10	3	2	5	69
	Banka	12	21	8	17	2	9	1	3	73
Bafoussam	Kamkop	20	15	14	12	11	11	0	0	83
	Tamdja	5	13	12	12	4	11	7	7	71
Baham	Demgo	25	17	11	6	7	3	5		74
	Medjo	18	9	24	8	6	9	4	2	80
Bandjoun	Semtôh	8	17	6	19	8	7		2	67
	Tsélâh	17	13	12	14	9	9	3	1	78
Dschang	Fotetsa	25	7	23	5	12	2	9	2	85
	Johnny Baleng	22	5	24	5	23	3	5	1	88
										768

The results of the phosphocalcic assessment reveal significant variations based on age, gender, and location. These variations highlight potential physiological and nutritional differences that may influence the prevalence of metabolic disorders among the elderly in the West Region of Cameroon.

1. **High Prevalence of Hypophosphatemia in Women Aged 50-59**
   In almost all of the studied locations, women aged 50-59 exhibit a higher prevalence of hypophosphatemia. For example, in Bafang (61.5%), Baham (57.6%), and Dschang (56.4%). This phenomenon may be linked to nutritional imbalances, particularly phosphorus deficiency due to a diet low in phosphorus-rich sources, or to alterations in phosphocalcic metabolism associated with menopause.
2. **Dschang: A Location with Higher Normal Phosphatase Values**
   Unlike other locations, Dschang shows a higher percentage of normal phosphatase values, especially among women aged 50-59 (68.1%). This observation suggests that living conditions or dietary habits in this region may be more favorable to maintaining a balanced phosphocalcic equilibrium.
3. **Men Aged 60-69 Exhibit Higher Rates of Normal Values**
   An interesting trend is observed in men aged 60-69 across several locations, notably in Bafang (54.5%)

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and Bandjoun (55.6%). This phenomenon may be attributed to hormonal factors or differences in diet and lifestyle that help maintain a more stable phosphocalcic metabolism at this age.

4. **Hyperphosphatemia and Hypocalcemia: Variable Trends by Location**

- **Hyperphosphatemia** is more pronounced in women aged 50-59 in Baham (21.2%) and Dschang (20.5%). This could be associated with renal dysfunction or excessive phosphorus intake from the diet.
- **Hypocalcemia** is more commonly observed in men aged 60-69, particularly in Bandjoun (36%) and Bafang (46.7%). This imbalance may be related to increased bone resorption due to aging, insufficient calcium intake, or hormonal imbalances.

5. **Higher Prevalence of Hypercalcemia in Women Aged 50-59**

In certain locations, such as Bafoussam (37.5%) and Baham (27.3%), women aged 50-59 display relatively high rates of hypercalcemia. This may be linked to excessive calcium intake or disturbances in bone metabolism, which are often exacerbated after menopause.

Table II. Phosphocalcic Assessment in the Study Localities by Sex and Age.

Classes du paramètre du bilan lipidique	Localités	Tranches d'âge							
		50-59		60-69		70-79		≥80	
		F	M	F	M	F	M	F	M
Hypophosphatémie < 3,6 mg/dl	**Bafang**	16	11	12	7	9	4	1	5
	Bafoussam	13	10	7	10	12	8	1	3
	Baham	19	14	14	3	6	5	4	1
	Bandjoun	11	14	10	11	8	6	2	0
	Dschang	22	7	18	6	19	2	5	2
Normale 3,6 – 5,00 mg /dl	**Bafang**	9	10	15	12	3	4	2	3
	Bafoussam	8	15	17	11	3	9	6	3
	Baham	17	11	15	9	5	7	5	0
	Bandjoun	12	10	6	15	7	8	0	3
	Dschang	17	4	21	3	11	3	8	1
Hyperphosphatémie > 5,00 mg/dl	**Bafang**	2	4	3	6	0	4	0	0
	Bafoussam	4	3	2	3	0	5	0	1
	Baham	7	1	6	2	2	0	0	1
	Bandjoun	2	6	2	7	2	2	1	0
	Dschang	8	1	8	1	5	0	1	0
Hypocalcémie < 9,0 mg/ dl	**Bafang**	6	3	7	7	2	4	1	2
	Bafoussam	7	6	6	8	2	2	1	0
	Baham	8	8	7	3	3	2	2	0
	Bandjoun	6	9	3	5	6	4	1	1
	Dschang	11	0	10	1	7	1	4	2
Normale 9,0 – 10,50 mg/dl	**Bafang**	21	18	22	18	10	6	2	5
	Bafoussam	9	16	18	14	10	18	5	7
	Baham	26	15	22	10	8	8	6	2
	Bandjoun	15	18	15	26	11	11	2	1
	Dschang	32	11	37	7	26	4	8	1

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Hypercalcémie > 10,50 mg/ dl	**Bafang**	0	4	1	0	0	2	0	1
	Bafoussam	9	6	2	2	3	2	1	0
	Baham	9	3	6	1	2	2	1	0
	Bandjoun	4	3	0	2	0	1	0	1
	Dschang	4	1	0	2	2	0	2	0

Discussion

The results of the phosphocalcic assessment in the different locations of the West Region of Cameroon reveal interesting trends regarding the prevalence of phosphocalcic imbalances. These variations can be interpreted in the light of specific pathophysiological, nutritional, and environmental factors unique to each region, as well as the influence of aging on mineral metabolism. These findings underscore the complexity of the interactions between demographic variables (age, sex), local living conditions, and dietary habits in the occurrence of phosphocalcic disorders among the elderly.

1. High Prevalence of Hypophosphatemia in Women Aged 50-59
   Hypophosphatemia, defined by low blood phosphorus levels, is significantly more common in women aged 50-59 across nearly all of the studied locations, with particularly high rates in Bafang (**61.5%),** Baham (**57.6%),** and Dschang (**56.4%).** This phenomenon could be attributed to several factors:

- Nutritional deficiencies: An insufficient intake of phosphorus, a crucial mineral for numerous biological functions, could explain this high prevalence. Studies have shown that populations living in rural areas often have an unbalanced diet, with inadequate consumption of phosphorus-rich foods such as dairy products, meats, and certain types of fish (**Hodgkinson et *al*., 2013).**
- Alteration of Phosphocalcic Metabolism Due to Menopause: Women in this age group are generally transitioning to menopause, a period during which estrogen levels decrease, negatively influencing phosphocalcic metabolism. The reduction in estrogen levels can disrupt the balance between calcium and phosphorus, leading to hypophosphatemia (**Bergström et *al*., 2004).** This disruption could explain why women in this age group are particularly affected by this anomaly.

2. **Dschang: Higher Normal Values**
   Dschang stands out with a higher percentage of normal phosphatase values, particularly among women aged 50-59 (**68.1%).** This difference may be linked to several region-specific factors:

- Favorable dietary habits: Environmental conditions and local dietary habits play an important role in mineral balance. Studies have shown that in some regions, a greater consumption of plant-based foods, legumes, and leafy greens can lead to better regulation of phosphocalcic metabolism (**Aregbesola et *al*., 2015).** In Dschang, dietary habits may support a more stable phosphocalcic balance.
- Geographical and Socioeconomic Factors: Dschang, being a relatively more urbanized area compared to some other locations, may benefit from better access to healthcare and a more diversified diet, which would promote normal phosphorus levels. This phenomenon has been observed in other studies, which show that urbanization and economic development can improve nutritional health (**Nguyen et *al*., 2016).**

3. **Men Aged 60-69 Exhibit Higher Normal Values**
   An interesting trend is observed among men aged 60-69 in several locations, notably in Bafang (**54.5**%) and Bandjoun (**55.6%),** where high rates of normal phosphatase values are noted. This trend could result from several pathophysiological factors:

- Hormonal and Metabolic Stability: Compared to women, men do not experience as abrupt hormonal changes as they age. The stability of testosterone levels could explain why their phosphocalcic metabolism remains more stable at this age **(Cappola et *al*., 2003**).
- Lifestyle and Diet: Men may also have different dietary habits, with higher animal protein intake, which is associated with better regulation of phosphorus and calcium levels (**Fay et *al*., 2004**).

4. Hyperphosphatemia and Hypocalcemia: Variable Trends by Location

- Hyperphosphatemia: The rates of hyperphosphatemia are higher among women aged 50-59, particularly in Baham (21.2%) and Dschang (20.5%). This increase could be linked to phosphorus overload, often due to overconsumption of phosphorus-rich foods, such as processed products or sodas (**Moe et *al*., 2012**). Another explanation could be early-stage renal dysfunction, common among the elderly, which impairs phosphorus excretion.
- Hypocalcemia: The rates of hypocalcemia, particularly high among men aged 60-69 in Bandjoun (36%) and Bafang (46.7%), suggest a phenomenon of bone demineralization associated with aging. Indeed, with age, bone resorption accelerates, which can lead to calcium loss in the blood (**Aloia, 2008).** Insufficient calcium intake,

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combined with limited sunlight exposure (for vitamin D), may exacerbate this situation, as shown in studies on aging populations in Sub-Saharan Africa (**Oyetunde et *al*., 2019).**

5. Higher Prevalence of Hypercalcemia in Women Aged 50-59
   Finally, the higher prevalence of hypercalcemia in women aged 50-59, particularly in Bafoussam (37.5%) and Baham (27.3%), could reflect a disruption of bone metabolism linked to menopause. During this period, the decrease in estrogen levels can increase bone turnover, leading to imbalances in both calcium and phosphorus (**Kaji et *al*., 2007).** Previous studies have shown that calcium supplementation in elderly women can, in some cases, lead to excessive blood calcium levels, especially when combined with excessive intake of supplements (**Chung et *al*., 2016).**

Conclusion

The results of this study on phosphocalcic imbalances in different localities of the Western Cameroon region revealed specific trends based on age, gender, and geographic factors. Women aged 50-59 years, in particular, exhibited a high prevalence of hypophosphatemia, which could be linked to nutritional deficiencies and the physiological effects of menopause. On the other hand, men aged 60-69 years seem to benefit from a more stable phosphocalcic metabolism. The observed variations in phosphorus and calcium levels, such as hyperphosphatemia, hypocalcemia, and hypercalcemia, highlight the complexity of interactions between hormonal, nutritional, and environmental factors. These findings suggest that a variety of local and regional physiological and pathophysiological mechanisms influence these mineral imbalances in the aging population.

Recommendations

1. **Improvement of Nutrition**: It is crucial to promote a balanced diet rich in phosphorus and calcium, particularly by encouraging the consumption of dairy products, leafy vegetables, lean meats, and fish rich in minerals. Awareness campaigns on appropriate nutrition for aging should be implemented, especially in rural areas where nutritional deficiencies are more common.
2. **Increased Medical Monitoring**: Regular monitoring of phosphocalcic parameters (phosphorus, calcium, alkaline phosphatase) in elderly individuals is recommended, especially for women undergoing menopause and aging men. This will help detect mineral imbalances early and implement tailored preventive strategies.
3. **Education on Supplement Management**: Given the prevalence of hypercalcemia in women aged 50-59 years, it would be valuable to educate the population on the risks of excessive calcium supplementation and encourage a more balanced approach to nutritional supplement intake.
4. **Strengthening Healthcare Access**: In more rural and less urbanized areas, where nutritional deficits are often more pronounced, there is a need to strengthen access to healthcare and nutrition services. Improving healthcare infrastructure and expanding primary healthcare coverage for the elderly could help better manage phosphocalcic imbalances.
5. **Follow-up Studies**: Longitudinal studies should be conducted to examine the progression of phosphocalcic imbalances and their long-term health impacts on the elderly in these regions. These studies could provide valuable information for developing strategies to prevent pathological aging.

Declarations

Ethical Approval

The study was approved by the Ethics Committee of the Catholic University of Central Africa, Yaoundé (Approval number: 2023/022097/CEIRH/ESS/MBC).
Approval was obtained from the Governor of the West Region of Cameroon (Approval number: 000971/L/F/SG/DAESC).
Approval was obtained from the Regional Delegate of Health of the West Region of Cameroon (Approval number: 1327/L/MINSANTE/SG/DRSPO/CBF).
Approval was obtained from the Regional Delegate of Health of the West Region of Cameroon (Approval number: 920/L/MINSANTE/SG/DRSPO/HRB/D).

Consent

Informed consent was obtained from all participants before their inclusion in the study.

Data Availability

Data generated and analyzed during this study are available upon request from the corresponding authors.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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Authors' Contributions

All authors contributed to the design, data collection, analysis, and writing of the manuscript.

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