

## Hematological parameters and prevalence of anemia among free-living elderly in south Brazil

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**Objective:** The aims of this study were to analyze the hematological parameters, the prevalence of anemia and the association between anemia and socioeconomic conditions in an elderly community-based population.

**Methods:** A population-based study was performed as part of the Multidimensional Study of the Elderly in Porto Alegre, Brazil (EMIPOA). An initial total of 1058 community residents aged 60 years and older were interviewed. Of these, 392 agreed to have a physical evaluation and a blood sample was taken from each. The hematological parameters analyzed in the blood samples included the hemoglobin concentration, mean cell volume (MCV), mean corpuscular hemoglobin concentration (MCHC) and red cell distribution width (RDW). The association between the variables and the diagnosis of anemia was assessed using the chi-squared test and a multiple logistic regression model.

**Results:** The overall prevalence of anemia was 12.8%. Anemia was present in 13.7% of women and in 10.4% of men. Normocytic normochromic anemia without anisocytosis was the most common type of anemia (46%). The assessment of erythrocyte morphology showed significant differences between anemic and non-anemic individuals (microcytosis = 12% vs. 1.5%, hypochromia = 40% vs. 8.8%, and anisocytosis = 26% vs. 7%). In the analysis of socioeconomic conditions, significant differences were found in respect to age and race.

**Conclusion:** The prevalence of anemia increases with age and is associated with race, microcytosis, hypochromia and anisocytosis. Anemia is not a condition that should be associated only with the aging process, as it may be due to pathological conditions that occur most frequently in this age group. As a result, a diagnosis of anemia warrants adequate clinical attention.

**Keywords:** Anemia; Hematology; Erythrocyte indices; Socioeconomic factors; Aging; Humans; Aged; Brazil

### Introduction

The aging process is related to a progressive decline in the functional reserves of multiple organ systems, which increases the probability of dysfunction and disease<sup>(1)</sup>. Hematopoietic modulation can become unstable with aging. Peripheral blood alterations include discrete and isolated elevations in the erythrocyte sedimentation rate, mild lymphocytopenia without clinical and laboratory manifestations, decreased mean hemoglobin and hematocrit concentrations, a slight increase in erythrocyte mean cell volume (MCV) and an increase in red cell osmotic fragility<sup>(2)</sup>.

According to the World Health Organization (WHO), anemia is defined as a condition in which the hemoglobin content is below normal. This situation occurs because of different pathophysiological mechanisms.

The reduction in the hemoglobin concentration is considered pathologic when the value is lower than 13 g/dL for men and 12 g/dL for women<sup>(3)</sup>. Anemia is considered a common problem in the elderly. The incidence of anemia increases with age and is associated with high risks of mortality and morbidity and a drop in the quality of life<sup>(4-6)</sup>. The reported prevalence of anemia is between 8% to 44% in the elderly, especially in over 60-year-old men<sup>(7)</sup>. The most prevalent types of anemia are due to nutritional deficiencies (malnutrition and iron, vitamin B12 and folic acid deficiencies) and chronic diseases (such as cancer, kidney disease and congestive heart failure)<sup>(8-10)</sup>. Nevertheless, the frequency of anemia of undetermined etiology constitutes 14-17% of all cases in the elderly<sup>(1)</sup>.

In order to characterize the type of anemia and formulate a differential diagnosis, the work-up should include physical exams and laboratory tests, such as evaluations of hematocrit, hemoglobin and red blood cell indices. The red blood cell indices should include the cell count, MCV, mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and red cell distribution width (RDW)<sup>(11)</sup>. In fact, the hemoglobin concentration is the parameter that is most commonly used as an indicator of the pathophysiological consequences of anemia<sup>(3)</sup>. However, this variable is not very specific or sensitive. Hemoglobin levels can be altered in different pathologic conditions, such as infectious and inflammatory processes, hemorrhage, protein-caloric malnutrition, associated to medications and smoking<sup>(12)</sup>. Another important parameter

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that is evaluated is the MCV. The MCV guides the diagnosis of anemia and helps in its classification<sup>(13)</sup>. However, the MCV value, that is, the mean size of the red cells (macrocytic, microcytic and normocytic), should be used together with the RDW, thus directing the interpretation of the variation in the size of red blood cells<sup>(14)</sup>.

Hematologic laboratory testing is very useful and is widely used in the clinical practice. This study aims to evaluate the prevalence of anemia and to verify the socioeconomic conditions of the elderly living in Porto Alegre, Brazil.

## Methods

### Study design

This observational cross-sectional study is part of an epidemiological project (Multidimensional Study of the Elderly in Porto Alegre) in a partnership between the Porto Alegre City Hall and the Institute of Geriatric and Gerontology (IGG) at the Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS).

### Population and sample

The inclusion criteria for this study were male and female residents who were older than 60 years of age. The sample size required to estimate the prevalence with an acceptable margin for a confidence interval of 95% to be calculated: (i) 1% for a prevalence lower than 1% and higher than 99%; (ii) 2% for a prevalence between 1% and 5% and between 95% and 99%; (iii) 3% for a prevalence between 5% and 10% and between 90% and 95%; and (iv) 5% for a prevalence between 20% and 80%. The minimum sample size of 447 elderly residents was calculated using the statistics program "sample.exe" from the statistical package PEPI, version 4. The selection was performed randomly and by residence and was stratified by census region of the Brazilian Institute of Geography and Statistics (IBGE). Approximately 1000 interviews were conducted at the homes of elderly residents, and it was believed that half of those interviewed would participate.

### Data collection

The interviews and the blood sample collections were performed between January and July of 2006. In the first stage, the instrument used for data collection was a data recording card, validated by the Social Service Department, containing questions related to the socioeconomic conditions of the patient. The interview was performed in the elderly patient's home with the help of trained interviewers (academic students, professionals or professors). The questions permitted open answers and were answered based on the patient's memory. The second stage of the evaluation was performed in the university (PUCRS) and included blood collection and data collection from different health areas; 512 elderly patients participated in this stage of the study.

The blood samples were collected in ethylenediaminetetraacetic acid (EDTA) tubes and were immediately sent to the laboratory for hematological testing.

Elderly subjects from whom an insufficient volume of blood was collected for the hematological test and who did not answer the socioeconomic and demographic interview questions were excluded from the study. The final sample included 392 elderly subjects.

### Laboratory parameters

The hematological testing was performed in the Hematology Sector of the Clinical Pathology Laboratory of São Lucas Hospital (PUCRS). The equipment used included a Sysmex XT-2000i automated blood analyzer (Sysmex, Kobe, Japan). The evaluated parameters included the hemoglobin concentration and red blood cell indices (MCV, MCHC and RDW).

The reference values used for this study were: hemoglobin of 13 g/dL for men and 12 g/dL for women, MCV 80-100fl, MCHC 31-35% and RDW up to 15%.

### Statistical analysis

The database was structured in Microsoft Office Excel 2007 and analyzed using Statistical Package for the Social Sciences (SPSS) software, version 17.0. The prevalence of anemia was calculated with a confidence interval of 95%. The differences between the groups with and without anemia were analyzed using a bivariate form with the chi-squared test. To verify the prevalence rate, the strength of the association was calculated using a confidence interval of 95%. The multivariate analysis was performed using a multiple logistic regression model. Statistical significance was defined as a p-value < 0.05.

### Ethical considerations

The study was approved by the Research Ethics Committee of PUCRS (protocol number 0502935). All of the study participants signed consent forms and authorized using the data for scientific purposes.

## Results

The population of this study included 392 elderly patients. From this population, 115 (29.3%) were men, and 277 (70.7%) were women. The total prevalence of anemia in this elderly population was 12.8%; the prevalence of anemia was 10.4% for men and 13.7% for women. The prevalence of anemia in relation to the demographic and socioeconomic data was dependent on age. As the age of the subjects increased there was also an increase in the prevalence of anemia (p-value = 0.008). As for race, the prevalence of anemia was higher in Blacks and mulattos than in white individuals (p-value = 0.002). When public sanitation was analyzed, the elderly who did not have basic sanitation in their homes showed a trend towards an increased prevalence of anemia (p-value = 0.075). There were no significant differences in the other variables analyzed in this study (Table 1). The multivariate analysis confirmed

Table 1 - Prevalence of anemia in the elderly ( $\geq 60$  years) according to demographic and socioeconomic data

Variable	Population n (%)	Prevalence anemia %	Prevalence ratio (95% CI)	p-value
<b>Gender</b>				
Male	115 (29.3)	10.4	1	0.375
Female	277 (70.7)	13.7	1.3 (0.7-2.4)	
<b>Age (years)</b>				
60-69	189 (48.2)	9.0	1	0.008
70-79	150 (38.3)	14.0	1.6 (0.9-2.8)	
80 or more	53 (13.5)	22.6	2.5 (1.3-4.9)	
<b>Education (years)*</b>				
0	40 (10.3)	17.5	1	0.204
1-4	213 (54.6)	8.9	0.5 (0.2-1.1)	
5-8	55 (14.1)	18.2	1.1 (0.4-2.5)	
9-11	47 (12.1)	14.9	0.8 (0.3-2.2)	
$\geq 12$	35 (9.0)	17.1	1.0 (0.4-2.6)	
<b>Race*</b>				
White	321 (82.7)	10.0	1	0.002
Black	42 (10.8)	23.8	2.4 (1.3-4.5)	
Mulatto	25 (6.4)	28.0	2.8 (1.4-5.7)	
<b>Married</b>				
Yes	142 (36.2)	11.3	1	0.506
No	250 (63.8)	13.6	1.2 (0.7-2.1)	
<b>Residence*</b>				
Own	320 (81.8)	12.8	1	0.722
Not own	71 (18.2)	11.3	0.9 (0.4-1.8)	
<b>Public sanitation*</b>				
Yes	371 (95.1)	11.9	1	0.075
No	19 (4.9)	26.3	2.2 (1.0-4.9)	
<b>Personal income*</b>				
Up to 1 BS	127 (33.2)	13.4	1	0.615
From 1 to 6 BS	208 (54.3)	12.5	0.9 (0.5-1.6)	
More than 6 BS	48 (12.5)	10.4	0.8 (0.3-2.0)	
<b>Family income*</b>				
Up to 2 BS	109 (32.7)	11.0	1	0.817
From 2 to 8 BS	174 (52.3)	12.1	1.1 (0.6-2.1)	
More than 8 BS	50 (15.0)	12.0	1.1 (0.4-2.7)	
<b>Total</b>	<b>392 (100)</b>		<b>12.8 (9.7-16.3)</b>	

CI: Confidence interval; BS: Basic salary (~US\$ 336.40) \*some data are missing

independent associations between age (p-value = 0.009) and race (p-value < 0.001) with anemia.

The red blood cell alterations were evaluated, and there were significant differences between the anemic and non-anemic groups: 6 (12.0%) versus 5 (1.5%) with microcytosis (p-value = 0.001); 20 (40.0%) versus 30 (8.8%) with hypochromia (p-value < 0.001) and 13 (26.0%) versus 24 (7.0%) with anisocytosis (p-value < 0.001), respectively.

Table 2 shows the anemia classification based on MCV, MCHC, and RDW. The hypochromia, microcytosis and anisocytosis occurred in four elderly patients with anemia (8.0%). Isolated hypochromic anemia occurred in 13 (26.0%) patients with anemia, and three (6.0%) patients with anemia had anisocytosis. Twenty-three (46.0%) elderly anemic patients demonstrated no alterations in the red blood cell indices.

Table 2 - Frequency distribution of red blood cell changes (MCHC, MCV and RDW) in elderly patients with and without anemia

MCHC	MCV	RDW	With anemia (N = 50)			Without anemia (N = 342)		
			n	(%)	95% CI	n	(%)	95% CI
Hypochromia	Microcytosis	< 15	0	(0.0)	0.0-5.7	0	(0.0)	0.0-0.9
		$\geq 15$	4	(8.0)	2.6-17.6	5	(1.5)	0.5-3.1
	Normocytosis	< 15	13	(26.0)	15.4-39.0	35	(10.2)	7.3-13.7
		$\geq 15$	3	(6.0)	1.5-14.9	10	(2.9)	1.5-5.1
Macrocytosis	< 15	0	(0.0)	0.0-5.7	0	(0.0)	0.0-0.9	
	$\geq 15$	0	(0.0)	0.0-5.7	0	(0.0)	0.0-0.9	
Normochromia	Microcytosis	< 15	1	(2.0)	0.1-9.0	3	(0.9)	0.2-2.3
		$\geq 15$	1	(2.0)	0.1-9.0	1	(0.3)	0.0-1.4
	Normocytosis	< 15	23	(46.0)	32.8-59.6	287	(83.9)	79.8-87.5
		$\geq 15$	5	(10.0)	3.7-20.2	14	(4.1)	2.3-6.6
	Macrocytosis	< 15	0	(0.0)	0.0-5.7	5	(1.5)	0.5-3.1
		$\geq 15$	0	(0.0)	0.0-5.7	1	(0.3)	0.0-1.4

MCHC: Mean corpuscular hemoglobin concentration; MCV: Mean corpuscular volume; RDW: Red cell distribution width; CI: Confidence interval

## Discussion

Anemia is a critical clinical problem in the elderly population with a significant public health impact. Data on the prevalence of anemia are varied and depend on the location and the population. The present study demonstrated a prevalence of anemia of 12.8% in the elderly of Porto Alegre. The low prevalence of anemia observed when using the hemoglobin concentration as the indicator was very similar to rates described in studies of elderly Americans, which report a prevalence of between 8.3% and 13.0%<sup>(15,16)</sup>. The similarities in prevalence may be associated with a greater concern with the aging population and the greater emphasis on their health. Another important factor that helps to explain the low prevalence of anemia in our study was that 67.3% of the elderly had a family income greater than 2 basic salaries (approximately US\$ 336.40).

The prevalence of anemia increases with advancing age: 9.0% among those aged  $\geq 60$  years, 14.0% in patients  $\geq 70$  years, and 22.6% in patients  $> 80$  years. Our results are similar to the study by Skjelbakken et al.<sup>(17)</sup> who reported that the prevalence of anemia among men aged 55-64 years was 3.5%, and the prevalence in over 85-year-old men was 29.6%. The prevalence of anemia was 2.2% for women who were 55-64 years of age and 16.5% in older women ( $> 85$  years). In the Third National Health and Nutrition Examination Survey (NHANES III), the prevalence of anemia increased to greater than 20% in octogenarians.<sup>(5)</sup> The increase in the frequency of anemia in older individuals is sometimes regarded as inherent to the aging process. Nevertheless, further investigations of the cause of anemia and the completion of treatment may help to improve clinical conditions in the elderly population. It is important to remember that anemia is multifactorial, and its occurrence may be due to the presence of cancer, inflammatory diseases, kidney disease (due to diabetes and hypertension), and the use of several drugs commonly required in the elderly population<sup>(18)</sup>.

Our findings demonstrate a higher prevalence of anemia in women than in men. These results are similar to those of a study that evaluated 284 elderly participants in the Family Health Program of Pernambuco, Brazil. The study found that the average prevalence of anemia in women was 12.6% versus

10.9% in men<sup>(14)</sup>. In contrast, a study performed by Olivares et al.<sup>(19)</sup> enrolled 274 elderly outpatients in Chile and found a low prevalence of overall anemia, but a higher prevalence among men (5.4%) compared to women (4.4%). This increase in the prevalence of anemia in men was also described in the NHANES III study, with men accounting for 11.6% of the cases of anemia versus 10.2% for women<sup>(5)</sup>. In an attempt to explain the different prevalence rates of anemia for men and women, some authors have argued that estrogens act as inhibitors of erythropoiesis and make women more vulnerable to the development of anemia. However, while postmenopausal estrogen levels decrease, there is an increase in red cell mass to levels that are similar to those in males, which makes it unreasonable to use different criteria for anemia in each gender<sup>(20,21)</sup>. Several studies have reported no significant differences between the genders, which demonstrates that there is a direct relationship between these factors.

When observing the relationship between anemia and ethnic groups, it was found that patients who described themselves as mulattos and Blacks had higher percentages of anemia (28.0% and 23.8%, respectively) compared to Whites (10.0%). Denny et al.<sup>(22)</sup> reported a prevalence of anemia of 34.0% for Blacks and 14.0% for Whites. In addition, Guralnik et al.<sup>(5)</sup> found a prevalence of 28.0% for Blacks and 9.0% for Whites. These differences can be explained by environmental conditions, such as nutritional intake, serum iron stocks, habitation, and access to health services. Furthermore, some genetic changes that lead to mutations in specific genes are found in most people of African descent, and therefore, diseases such as sickle cell anemia and thalassemia- $\alpha$  could be responsible for the significant decrease in hemoglobin levels in this population<sup>(23)</sup>.

Elderly patients with anemia were classified according to the assessment of red blood cell indices. Most patients had normochromic and normocytic anemia, which suggests a diagnosis of anemia of chronic disease. Data reported by Carmel<sup>(24)</sup> also indicate a higher prevalence of normocytic and normochromic anemia and a smaller proportion of cases of microcytic anemia (MCV = 75-82 fL). In contrast, the study by Failace<sup>(20)</sup> describes that the majority of cases are due to hypochromic anemia and iron deficiency. Hypochromic anemia represents the second most common pattern observed in our study.

## Conclusion

Race is a factor that is linked to higher rates of anemia. Likewise, increasing age is closely associated with hemoglobin levels and the prevalence of anemia, which is mostly normocytic and normochromic. However, anemia is not a condition that should only be associated with the aging process. Anemia may be due to pathological conditions that occur more frequently in elderly patients, and thus it deserves adequate clinical attention.

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