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Cross-sectional study on the prevalence of anemia among rural elderly in Asan

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Abstract

The objective of this study was to assess the prevalence and clinical characteristics of anemia and to define the risk factors for anemia in older Koreans in Asan. From January to February 2002, five hundred sixty two community-dwelling older adults aged over 60 years were selected from a cross sectional study. All subjects underwent laboratory tests, which included a complete blood cell count, reticulocyte, liver and renal functional tests, lipid profiles and iron status tests. The median age was 68.6 years (range, 60-92 years). The mean levels of hemoglobin were 14.4 ± 1.3 g/dL in men and 12.9 ± 1.0 g/dL in women, and the overall prevalence of anemia was 12.5% in all subjects, 10.8% in men and 13.6% in women. The prevalence of anemia was the lowest among age group of 60-69 (10.0%) followed by 70-79 (15.5%), and the highest among age over 80 (20.7%), but the difference was significant only for men. The age difference was more distinct in men than in women ($p<0.05$). The mean hemoglobin level was significantly lower in the subjects aged over 80 y than those in the 60-69 y group ($p<0.05$). According to a logistic regression analysis, lower albumin and higher creatinine levels were identified as independent risk factors of anemia among older adults in Asan. In conclusion, the overall prevalence of anemia in our study group was 12.5% and the highest (20.7%) among those aged over 80 y.

Key Words: Anemia, elderly, rural Korea, albumin, creatinine

Introduction

Anemia is a common condition at all ages, but this is especially true among the older population since the prevalence of anemia rises with advancing age (Baducci, 2003; Nissenson *et al.*, 2003). According to the results of some epidemiologic studies, the prevalence of anemia among adults increases sharply after the age of 60 (Ania *et al.*, 1994, 1997; Smith, 2000). Due to the rising tendency of the aging population in a modern society, the prevalence of anemia is also expected to rise in the future. Anemia represents a sign of serious diseases. Thus, if not treated properly, anemia can cause severe complications, especially among the older population. In a large epidemiologic study with the subjects over 65 years who were hospitalized for acute myocardial infarction, lower hematocrit levels were reported to be associated with higher mortality rates (Izaks *et al.*, 1999; Kikuchi *et al.*, 2001). Undiagnosed and untreated anemia is also associated with a decreased quality of life (Ma *et al.*, 1999; Moreno *et al.*, 2000), and therefore, early detection of anemia among the older population is an important topic.

In order to establish a proper diagnostic and treatment strategy, the assessment of the prevalence and clinical characteristics of the elderly population in rural area is important since many studies have been conducted in urban areas rather than in rural areas. Number of studies have reported age-specific hematologic values of older population (Ania *et al.*, 1994, 1997; Celestin-Roux *et al.*, 1987; Choi *et al.*,. 2004; Hake *et al.*, 1983; Izaks *et al.*, 1999; Salive *et al.*, 1992; Smith, 2000; Timiras & Brownstein, 1987; Zauber & Zauber, 1987), but the interpretation of the results is complicated due to possible limitations of study populations and the availability of data on related factors. Among the number of studies reported so far on the prevalence of anemia in the older population, only a limited number of studies have been conducted on community-base setting (Izaks *et al.*, 1999; Salive *et al.*, 1992). Furthermore, there are even less studies on the prevalence and clinical characteristics of anemia in East Asian countries and the rural area of these countries.

The objectives of this study, therefore, were focused on assessing the prevalence and clinical characteristics of anemia and on defining the risk factors for anemia among older rural Koreans living in Asan.

Subjects and Methods

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The subjects of this study were selected from a community Health and Nutrition Survey for citizens of Asan between January and February 2002. The study population was selected from five

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districts in Asan, South Korea. Five hundred sixty two community-dwelling older adults aged over 60 years were invited to participate in the Health and Nutrition Survey. Informed consent was provided by all subjects before participating in the study.

Blood sampling was conducted in the regional Public Health Centers of the City of Asan municipal government. Blood pressure, height and weight were measured, and body mass index (BMI) was calculated from measured weights and heights (kg/m^2). Approximately 10 ml of venous blood was collected from each participant after an overnight fast and divided into two tubes: 4 ml for zinc protophorphyrin (ZPP), blood cell counts and hemoglobin (Hb) analyses, and 6 ml of blood was immediately separated for analyses of biochemical indexes in serum. ZPP levels were measured by a portable hematofluorimeter (Aviv-206, Aviv, Lakewood, NJ) at the study sites (Blumberg *et al.*, 1977). Complete blood and reticulocyte counts were obtained using a Coulter counter (Coulter Electronics, Hialeah, FL). Hb was assayed by the cyanmethemoglobin method (model Ac-T, Beckman Coulter, Fullerton, CA). Serum levels of iron and total iron binding capacity (TIBC) were determined using an automatic analyzer (TBA-40FR biochemical analyzer, Hitachi, Tokyo, Japan). Liver and renal function tests (aspartate aminotransferase, AST; alanine aminotransferase, ALT; alkaline phosphatase, ALP; blood urea nitrogen, BUN and creatinine), lipid profiles (serum total cholesterol, TCHO and triacylglycerol, TG) were also determined using a Hitachi 747 chemistry analyzer (Hitachi, Tokyo, Japan).

According to the World Health Organization (WHO) criteria, anemia was defined as hemoglobin levels less than 13 g/dL for men and less than 12 g/dL for women (DeMaeyer & Adiels-Yagman, 1985). Mean corpuscular volume (MCV) was used to classify the anemia as microcytic (< 80 fL), normocytic (80-100 fL), or macrocytic (> 100 fL).

Statistical analysis

The subjects were categorized into three groups according to age (age 60-69 y, 70-79 y, and 80 y or older). Differences in hemoglobin levels of the age groups were analyzed using ANOVA with Tukey's multiple comparison test. Differences in the prevalence of anemia by age groups were tested using Chi square test. Comparisons between the anemic and normal groups were conducted by Student's t-test. Statistical comparisons were also performed according to logistic models to identify risk factors for anemia in the older subjects. All statistical analyses were conducted using SPSS version 14.0. A p value less than 0.05 was established as statistically significant. All reported p values were two-sided.

Results

Characteristics of the study subjects

Of 562 subjects who participated in this study, 232 (41.3%) were men and 330 (58.7%) were women. The mean age was 68.6 years (range, 60-92) for both men and women (Table 1). Mean hemoglobin was 14.4 ± 1.3 g/dL in men and 12.9 ± 1.0 g/dL in women. MCV was 95.9 ± 4.9 fL for men and 92.4 ± 3.8 fL for women. Liver and renal function tests, lipid profiles, and iron status test results are listed in Table 1.

Table 1. General characteristics of the subjects[1)]

Variables	Men (n=232)	Women (n=330)	P value
Age (y)	68.6 ± 6.0	68.6 ± 6.0	NS
Height (cm)	163.5 ± 5.7	149.4 ± 5.6	0.000
Weight (kg)	62.0 ± 8.7	56.3 ± 9.4	0.000
BMI (kg/m^2)	23.1 ± 2.7	25.2 ± 3.6	0.000
Body fat (%)	24.3 ± 6.0	37.4 ± 8.4	0.000
WBC ($\times 10^9$/L)	6.3 ± 1.9	5.4 ± 1.8	0.000
RBC ($\times 10^6$/L)	445.5 ± 44.4	414.8 ± 33.3	0.000
Hemoglobin (g/dL)	14.4 ± 1.3	12.9 ± 1.0	0.000
Hematocrit (%)	42.7 ± 3.8	38.3 ± 2.8	0.000
MCV (fL)	95.9 ± 4.9	92.4 ± 3.8	0.000
Platelet ($\times 10^9$/L)	233.4 ± 58.9	258.7 ± 74.0	0.000
AST (IU/L)	28.8 ± 17.7	23.1 ± 8.2	0.000
ALT (IU/L)	17.1 ± 11.3	14.6 ± 8.2	0.004
ALP (IU/L)	205.1 ± 63.4	213.6 ± 53.1	NS
Total protein (g/dL)	7.5 ± 0.5	7.6 ± 0.4	0.032
Albumin (g/dL)	4.5 ± 0.3	4.5 ± 0.2	NS
TCHO (mg/dL)	190.3 ± 35.8	215.4 ± 35.0	0.000
Triglyceride (mg/dL)	175.6 ± 118.0	172.1 ± 91.6	NS
Glucose (mg/dL)	118.9 ± 56.3	110.8 ± 36.7	NS
BUN (mg/dL)	15.1 ± 4.8	15.0 ± 4.5	NS
Creatinine (mg/dL)	0.96 ± 0.19	0.81 ± 0.14	0.000
Iron (μg/dL)	126.1 ± 48.3	99.2 ± 33.5	0.000
TIBC	348.5 ± 64.5	361.4 ± 50.8	0.008

[1)] Values are mean ± SD and comparisons between men and women are performed by Student's t-test. Abbreviations: BMI, body mass index; WBC, white blood cell; RBC, red blood cell; MCV, mean corpuscular volume; AST, aspartate aminotransferase; ALT, alanine aminotransferase; ALP, alkaline phosphatase; TCHO, total cholesterol; BUN, blood urea nitrogen; TIBC, total iron binding capacity.

Prevalence of anemia and hemoglobin levels by age groups

Among the participants of the study, 70 subjects (25 men and 45 women) were anemic, which was 12.5% prevalence rate of anemia in this population. The prevalence of anemia was 10.8% for men and 13.6% for women, but the gender difference was not statistically significant. The prevalence of anemia by age group was the lowest among age group of 60-69 y (10.0%) followed by age group of 70-79 y (15.5%), and the highest among age group over 80 y (20.7%), but the difference was not statistically significant for the total subjects (Table 2). The age difference was more distinct for men than for women with significant difference ($p<0.05$) of anemia in men. Mean hemoglobin levels were different by age groups, showing the significantly lower level among the subjects aged over 80 y than the subjects in the age group of 60-69 y ($p<0.05$).

Table 2. Comparison of hemoglobin and prevalence of anemia by age groups

	60-69 y (n=340)	70-79 y (n=193)	80 y or older (n=29)	Total (n=562)
	Mean ± SD[1]			
Hemoglobin (g/dL)	13.6 ± 1.3[a]	13.3 ± 1.2[ab]	13.1 ± 1.6[b]	13.5 ± 1.3
Prevalence of anemia[2]	N (%)			
Men*	10 (6.9)	13 (16.9)	2 (20.0)	25 (10.8)
Women	24 (12.3)	17 (14.7)	4 (21.1)	45 (13.6)
Total	34 (10.0)	30 (15.5)	6 (20.7)	70 (12.5)

[1] Mean values within a row with unlike superscript letters were significantly different with ANOVA and Tukey's post-hoc test.
[2] Differences in the prevalence of anemia by age groups were analyzed by Chi-square test.
* $p<0.05$

Table 3. Comparisons of the anemic and non-anemic groups[1]

Variables	Anemic (n=70, 12.5%)	Non-anemic (n=492, 87.5%)	P value[2]
Prevalence of anemia by sex	N (%)		0.318
Men	25 (10.8)	207 (89.2)	
Women	45 (13.6)	285 (86.4)	
	Mean ± SD		
Age (y)	70.2 ± 6.6	68.3 ± 6.0	0.014
Height (cm)	153.2 ± 8.1	155.6 ± 9.0	0.027
Weight (kg)	54.5 ± 8.0	59.3 ± 9.6	0.000
BMI (kg/m^2)	23.3 ± 3.3	24.5 ± 3.3	0.005
Body fat (%)	30.0 ± 9.8	32.3 ± 9.9	0.031
WBC (× 10^9/L)	5.6 ± 2.1	5.8 ± 1.9	NS
RBC (× 10^6/L)	376.4 ± 31.4	434.7 ± 37.0	0.000
Hemoglobin (g/dL)	11.6 ± 0.9	13.8 ± 1.1	0.000
Hematocrit (%)	34.7 ± 2.4	40.9 ± 3.4	0.000
MCV (fL)	92.4 ± 5.5	94.1 ± 4.5	0.000
Platelet (× 10^9/L)	250.7 ± 92.6	247.9 ± 65.4	NS
AST (IU/L)	25.1 ± 11.2	25.5 ± 13.5	NS
ALT (IU/L)	14.4 ± 7.9	15.8 ± 9.9	NS
ALP (IU/L)	199.8 ± 49.8	211.6 ± 58.1	NS
Total protein (g/dL)	7.3 ± 0.4	7.6 ± 0.5	0.000
Albumin (g/dL)	4.4 ± 0.2	4.5 ± 0.2	0.000
TCHO (mg/dL)	191.2 ± 38.7	207.0 ± 36.8	0.002
Triglyceride (mg/dL)	134.4 ± 78.5	179.1 ± 105.2	0.000
Glucose (mg/dL)	121.5 ± 67.1	113.1 ± 42.1	NS
BUN (mg/dL)	15.5 ± 4.8	15.0 ± 4.6	NS
Creatinine (mg/dL)	0.89 ± 0.25	0.87 ± 0.17	NS
Iron (μg/dL)	90.5 ± 27.2	113.1 ± 43.4	0.000
TIBC	350.9 ± 56.6	356.8 ± 57.2	NS

[1] Abbreviations: BMI, body mass index; WBC, white blood cell; RBC, red blood cell; MCV, mean corpuscular volume; AST, aspartate aminotransferase; ALT, alanine aminotransferase; ALP, alkaline phosphatase; TCHO, total cholesterol; BUN, blood urea nitrogen; TIBC, total iron binding capacity.
[2] Comparisons between anemic and non-anemic groups are performed by chi-square test or Student's t-test.

Characteristics and risk factors of anemia

Anemia was characterized by MCV as 0.9% microcytic, 90.2% normocytic, and 8.9% macrocytic. Therefore, the most common pattern of anemia was normocytic anemia (data not shown). To define the characteristics of subjects with anemia, we compared variables in the normal and anemic groups. Subjects with anemia showed statistically lower values in weight, height, BMI, body fat, total protein, albumin, total cholesterol, triglycerides and indexes of iron status than those with normal hemoglobin levels. Among iron status indexes, TIBC was the only index which did not show a significant difference between anemic and non-anemic subjects. Age was statistically higher in the anemic group than in the non-anemic group (Table 3).

Table 4. Risk factors for anemia by logistic regression analysis[1]

Variables	Estimate	SE	P value	OR (95% CI)
Age	0.013	0.023	0.569	1.013 (0.968, 1.061)
Women	0.772	0.549	0.159	2.163 (0.738, 6.344)
Body fat	-0.031	0.029	0.278	0.969 (0.917, 1.025)
Albumin	-1.826	0.594	0.002	0.161 (0.050, 0.516)
Creatinine	2.579	0.930	0.006	13.189 (2.131, 81.641)
Triglyceride	-0.005	0.002	0.011	0.995 (0.991, 0.999)

[1] Abbreations: SE, standard error; OR, odds ratio; CI, confidence interval.

Logistic regression analysis was performed to identify independent risk factors of anemia among the subjects and the results are as in Table 4. The parameters identified as significant independent risk factors of anemia were lower albumin level and higher creatinine level. Total triglyceride showed a very marginal protective effect (odds ratio of 0.995 with 95% confidence interval of 0.991-0.999).

Discussion

Anemia among the older population used to be considered as a part of the normal physiological process of aging (Lipschitz & Mitchell, 1981). However, the current trends more likely consider anemia among the older population as a type of pathologic condition caused by underlying diseases (Hake *et al.*, 1983; Salive *et al.*, 1992; Stander 1989). Thus, anemia is no longer viewed as a natural physiological change of an accompaniment of aging. In this study, we assessed the prevalence of anemia in a community-based group in the rural area that was fully ambulatory and capable of normal, active daily life. Our results showed that the prevalence of anemia among rural older subjects was 12.5% (10.8% in men and 13.6% in women). These are lower than the results of other studies (Ania *et al.*, 1994; Choi *et al.*, 2004; Izaks *et al.*, 1999; Salive *et al.*, 1992; Timiras & Brownstein, 1987), but differences in the age of participants and the study settings make direct comparisons impossible. When the prevalence was compared with urban Korean elderly (Choi *et al.*, 2004) in men and women separately, the prevalence of anemia in rural men (10.8%) was higher than the urban men (9.9%) while rural women showed the lower prevalence than urban women (13.6% vs. 14.7%). As shown in the previous report on the nutritional status of the rural population (Kim *et al.*, 2007), rural men might be more subject to poor nutrition quality than both rural women and urban men. The low socioeconomic status

of rural men may have caused higher anemia prevalence than urban men. Consequently, more efforts to improve nutritional status of rural men are needed.

The prevalence of anemia is significantly higher in the older group in this study as other epidemiologic studies have reported (Ania *et al.*, 1994, 1997; Choi *et al.*, 2004; Salive *et al.*, 1992; Smith, 2000). As shown in Table 2, significant differences were found between the anemia prevalence in those aged 60-69 y and those aged 80 y or older. In addition to the prevalence study, we investigated the characteristics of anemia and risk factors in the older population by comparing variables for the normal and anemic groups. Anemic subjects showed lower anthropometric status, total protein and albumin levels, lipid profiles (cholesterol and triglyceride) and all iron status indexes except TIBC. Also the significantly higher age in the anemic subject was reported. When the characteristics of anemia were analyzed by MCV values, normocytic anemia was the most common type of anemia. However, the rate of macrocytic anemia resulting from vitamin B_{12} and/or folate deficiency among this population was higher (8.9%) than the urban older population (3.0%, Choi *et al.*, 2004). Since anemia is commonly caused by various pathological conditions such as chronic disease, iron deficiency, vitamin B_{12} and/or folate deficiency, the specific characterization of anemia in this population needs to be conducted with the evaluation of vitamin B_{12} and folate status.

Low serum albumin and high creatinine levels were analyzed to be the risk factors of anemia among the rural older population. The low albumin level might be due to either insufficient nutrient intakes or chronic illness. The high creatinine level is associated with anemia due to a reduction in the circulating erythropoietin level (Carmel, 2001). Therefore, we may speculate that the anemia of this population could be due to insufficient nutrient intakes and chronic diseases; however, because of the lack of information on nutrient intake and chronic disease status, further investigation is needed. Considering the rural older population is not easily accessible to better medical services than the urban population, the underlying condition of anemic subjects could be due to causes other than iron deficiency. Approximately 85% of anemia cases have been defined (Carmel, 2001; Smith, 2000) and reported prevalence of vitamin B_{12} deficiency among older adults aged over 60 y was about 10-15 % (Baik & Russell, 1999). Therefore, more specific tests such as analyses of vitamin B_{12} and folate status and tests for the underlying chronic disease conditions would be helpful to reveal additional causes of anemia in this population.

In this study, we found 12.5% overall prevalence of anemia among older adults living in rural Asan. This rate is lower than the previously reported anemia prevalence among the urban older Koreans. However, anemia in men of this study was higher than the urban older men. Morphologically, normocytic anemia was the most common type in this population while more macrocytic anemia was reported than the urban population. Significant risk factors identified were low serum albumin and high creatinine levels. The cause of anemia in this population might be mostly due to chronic disease and insufficient micronutrient intakes such as iron, vitamin B_{12} and/or folate. For the future work, nutritional status of micronutrients must be evaluated either by dietary and biochemical analyses and strategies to improve the nutritional and health status of the rural older population must be developed.

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