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ORIGINAL ARTICLE

The prevalence of anemia and iron depletion in the population aged 10 years or older

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Background
Anemia and iron depletion continue to be common disorders in the world. This study was aimed at assessing the prevalence of anemia and iron depletion in apparently healthy Koreans aged 10 years or more.

Methods
We used the data of the 4th Korean National Health & Nutrition Examination Survey (KNHANES), which assessed 7,607 individuals (3,337 males and 4,270 females). Iron depletion was defined as serum ferritin less than 15 ng/mL.

Results
In males, mean hemoglobin (Hb) concentration decreased after the age of 50. The prevalence of anemia was 7.1% in 60 to 69 year olds and 12.3% in men aged 70 or older. As for females, the prevalence of anemia was 8.8% in 15 to 17 year olds, 16.7% in 18 to 49 year olds, 10.9% in 60 to 69 year olds, and 18.2% women aged 70 or older. In males, the prevalence of iron depletion was 8.6% at ages 10 to 14 years, 3.9% at 15 to 17, and 2.6% at 70 years or older. In females, the prevalence of iron depletion was 17.2% at ages 10 to 14 years, 24.1% at 15 to 17, 33.0% at 18 to 49, and 5.7% at 70 years or older. Although normocytic anemia was most common in both males and females, the proportion of microcytosis and macrocytosis increased at age 70 or older.

Conclusion
The prevalence of anemia and iron depletion was high in women of reproductive age and in the elderly. Considering the rapid increase in the older population, an intervention to prevent anemia and iron depletion is imperative.

Key Words Anemia, Hemoglobin, Iron depletion, Prevalence

INTRODUCTION

Despite a sharp decline in the prevalence of anemia during the past several decades owing to better nutrition and iron-fortified foods, anemia continues to remain the most common disorder in the world [1-3]. According to the statistics of the World Health Organization (WHO) [4], the prevalence of anemia is 48% in preschool-age children (less than 5 years of age), 25% in school-age children (5 to 14 years), 13% in males (15 to 59 years), 42% in pregnant females, 30% in women of reproductive age (15 to 49 years), and 24% in the elderly (>60 years). It is of note that anemia is particularly prevalent among three population groups, i.e., preschool-age children, pregnant females, and women of reproductive age.

In a study within Korea [5], the prevalence of iron deficiency was 9% to 31% in females aged 10 to 18 years. Unfortunately, studies have not been conducted regarding the prevalence of anemia in middle-aged adults. About 10 years ago, the prevalence of anemia in adults over the age of 60 who volunteered to participate in a study living in the southwest area of Seoul was 10% in males and 14% in females [6].

Anemia is an independent risk factor for increased morbidity and mortality and decreased quality of life [7, 8]. Although anemia is caused by a wide variety of diseases, the most significant contributor is iron deficiency, especially in Korea where hemoglobinopathies are rare. It is well known that iron deficiency anemia (IDA) causes fatigue, decreases work capacity, reduces resistance to infection, and impairs intellectual performance such as learning [9-11]. As iron deficiency alone without overt anemia can be clearly associated with retardation of verbal learning and memory as well as lowered standardized math scores [12, 13], it is imperative to prevent the development of iron deficiency/depletion [11, 14, 15]. In addition, iron deficiency may reflect other nutritional problems, because an unbalanced diet is not confined to intake of iron alone.

Ten years after the previous report, it seemed to be important to know the change of anemia prevalence and iron status. We aimed at assessing the prevalence of anemia and iron depletion in the Korean population aged 10 years or older.

MATERIALS AND METHODS

As with the general aim of the Korea National Health & Nutrition Examination Survey (KNHANES) to assess the health and nutritional status of the Korean population, the Fourth KNHANES IV-2 was performed in 2008 by the Korea Centers for Disease Control and Prevention. A total of 7,607 individuals (3,337 males and 4,270 females) over 10 years of age were included in this analysis, with blood samples being obtained by venipuncture under informed consent. We divided adolescents into two groups (10 to 14 years and 15 to 17 years), because 95% of girls do not reach menarche until 14.5 years of age. Pregnant women were not included. Among the 349 males and 350 females who were over 70 years of age, one male and one female were each 90 years of age.

Hemoglobin (Hb) and mean corpuscular volume (MCV) were determined by XE-2100D (Sysmex, Kobe, Japan) in Neodin. Serum ferritin levels were measured by an immunoradiometric assay (1470 WIZARD gamma-counter, PerkinElmer, Finland).

Anemia was defined in accordance to WHO criteria: Hb less than 12 g/dL in adolescents aged 10 to 14 years, less than 13 g/dL in males >15 years, and less than 12 g/dL in all females. Because serum iron and total iron binding capacity were not measured in this study, the iron depletion was defined as the ferritin level <15 ng/mL. Macrocytosis was defined as MCV >100 fL and microcytosis as MCV <80 fL.

RESULTS

For males, mean Hb concentration was 14.0 g/dL in 10 to 14 year olds, 15.2 g/dL in 15 to 17 year olds, and 15.4 g/dL in 18 to 49 year olds. Thereafter, it decreased with age to 14.3 g/dL in men 70 or older (Fig. 1).

For females, mean Hb concentration was 13.4 g/dL in 10 to 14 year olds, 13.2 g/dL in 15 to 17 year olds, 12.9 g/dL in 18 to 48 year olds, and 12.9 g/dL in women 70 or older.

Mean ferritin levels are shown in Fig. 2 according to the age and sex.

For males, the prevalence of anemia was 0.8% at ages 10 to 14 years, 0.9% at 18 to 49 years, 7.1% in 60 to 69 year olds, and 12.3% in men 70 or older (Table 1). For females, the prevalence of anemia was 3.4% in 10 to 14 year olds, 8.8% in 15 to 17 year olds, 16.7% in 18 to 49 year olds, 10.9% in 60 to 69 year olds, and 18.2% in women 70 or older (Table 2).

In males, the prevalence of iron depletion was 8.6% in ages 10 to 14 years, 3.9% in 15 to 17 years, 1.5% in 18 to 49 years, and 2.6% in men 70 years or older (Table 1). In females, the prevalence of iron depletion was 17.2% in 10 to 14 year olds, 24.1% in 15 to 17 year olds, 33.0% in 18 to 49 year olds, and 5.7% in women 70 years or older (Table 2).

The prevalence of microcytosis was less than 1% in men aged 10 to 69 years. Although normocytic anemia was most common in both males and females, the proportion of

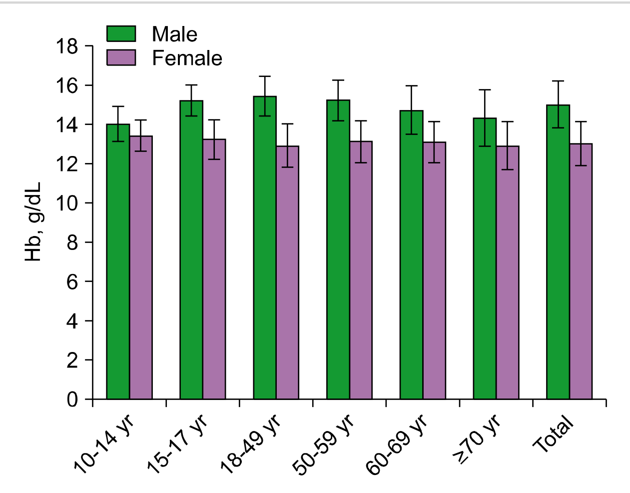

Fig. 1. Mean and standard deviation of hemoglobin according to the age and sex.

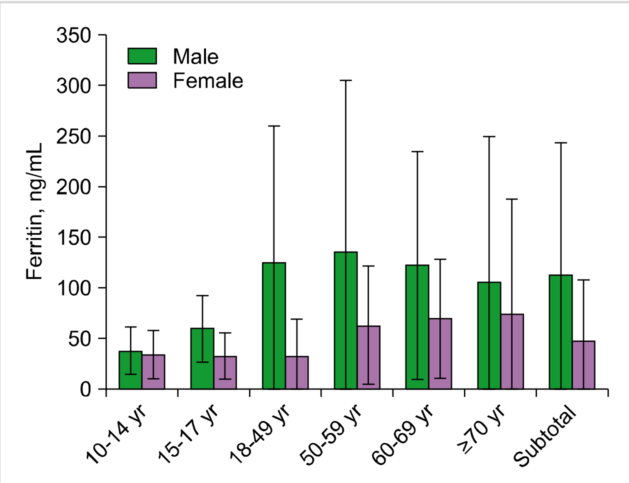

Fig. 2. Mean and standard deviation of ferritin according to the age and sex.

Table 1. The prevalence of anemia[a)], microcytosis and iron depletion[b)] in males.

Hematologic	10-14 yr (N=360)		15-17 yr (N=153)		18-49 yr (N=1,573)		50-59 yr (N=481)		60-69 yr (N=421)		≥70 yr (N=349)	
Parameters criteria	N	%	N	%	N	%	N	%	N	%	N	%
Anemia	3	0.8	0	0	14	0.9	12	2.5	30	7.1	43	12.3
Ferritin <15 ng/mL	31	8.6	6	3.9	23	1.5	4	0.8	11	2.6	9	2.6
Anemia with												
MCV >100 fL	0	0	0	0	2	0.1	0	0	0	0	3	0.9
MCV 80-100 fL	3	0.8	0	0	10	0.6	11	2.3	28	6.7	35	10.0
MCV <80 fL	0	0.0	0	0	2	0.1	1	0.2	2	0.5	5	1.4

[a)]Anemia was defined in accordance with WHO Hb thresholds: less than 12 g/dL in adolescents aged 10 to 14 yr, and less than 13 g/dL in adult males. [b)]Iron depletion was defined as ferritin less than 15 ng/mL.
Abbreviation: MCV, mean corpuscular volume.

Table 2. The prevalence of anemia[a)], microcytosis and iron depletion[b)] in females.

Hematologic	10-14 yr (N=297)		15-17 yr (N=137)		18-49 yr (N=2,064)		50-59 yr (N=632)		60-69 yr (N=613)		≥70 yr (N=527)	
Parameters criteria	N	%	N	%	N	%	N	%	N	%	N	%
Anemia	10	3.4	12	8.8	344	16.7	57	9.0	67	10.9	96	18.2
Ferritin <15 ng/mL	51	17.2	33	24.1	681	33.0	46	7.3	40	6.5	30	5.7
Anemia with												
MCV >100 fL	0	0	0	0	2	0.1	1	0.2	0	0	4	0.8
MCV 80-100 fL	6	2.0	9	6.6	252	12.2	47	7.4	61	10.0	88	16.7
MCV <80 fL	4	1.3	3	2.2	90	4.4	9	1.4	6	1.0	4	0.8

[a)]Anemia was defined as hemoglobin less than 12 g/dL in all females. [b)]Iron depletion was defined as ferritin less than 15 ng/mL.

microcytosis and macrocytosis increased with age, particularly after age 70. As for females, the prevalence of microcytosis was 1.3% in 10 to 14 year olds, 2.2% in 15 to 17 year olds, 4.4% in 18 to 49 year olds, and 1.4% in 50 to 59 year olds.

DISCUSSION

Anemia, iron depletion and iron deficiency are global public health problems with various cultural, dietary, and infectious backgrounds in developed and developing countries [16]. In this study, anemia and iron depletion were common in women of reproductive age. In males, mean Hb concentration showed a decline after the age of 50.

The prevalence of anemia in Korean school girls aged 12 to 14 years was reported to be 13.4% in 1990 and 5.7% in 2000 [17, 18]. In the case of non-pregnant females of reproductive age, the prevalence of anemia in this study was 17.9%, which was similar to the proportions reported by studies of America (17.8%) and Europe (19.0%) cited in WHO data [4].

Anemia prevalence has increased with age. About a decade ago, the prevalence of anemia over the age of 60 was 10.2% in men and 14.1% in women, with normocytic anemia being the most common type [6]. In another study [19], the prevalence was 10.8% in males and 13.6% in females. A marked increase has occurred in the prevalence of anemia in males over 60 years of age compared to males aged 18 to 59 years. In our study, the anemia prevalence among males was 7.1% in 60 to 69 year olds and 12.3% in those aged 70 years old or more. In spite of the high prevalence of anemia in people aged 70 or older (12.3% in males and 18.2% in females), the proportion of iron depletion was relatively low, that is, 2.6% and 5.7%, respectively. Bross et al. [20] asserted that about one-third of older persons have anemia secondary to a nutritional deficiency, one-third have anemia caused by chronic inflammation or chronic kidney disease, and one-third have unexplained anemia.

In our study, the proportion of microcytosis and macrocytosis increased with age, which may mean that nutritional anemia was mainly associated with a deficiency of iron and/or vitamins [20]. With the rapid increase in the older population, the high prevalence of anemia seems to be an emerging problem of the older age group.

Of a review of the prevalence of iron deficiency in the United States, 11% of adolescent girls were iron-deficient [21]. In another study [22], the odds of IDA among children aged 12 to 15 years in households with insecure access to food were 2.95 times the odds of children in households with food security.

In Korea, the prevalence of iron depletion was reported to be 26% in 1990's middle school females [17], and 23% in 2000 [18]. The prevalence of iron depletion was 26%

in college students [23] by a diagnostic cut-off value of serum ferritin less than 15 ng/mL. Those findings may reflect a negative iron balance in that group in the face of high iron requirements due to menstrual blood loss and poor dietary intake [5, 24, 25]. In this study, the prevalence of iron depletion was 17.2% in those aged 10 to 14 years, 24.1% in those aged 15 to 17 years, and 33.0% in women aged 18 to 49 years. This result shows little change of the iron depletion prevalence compared with that of 20 years ago.

The high prevalence of iron depletion may accompany other nutritional problems, because an unbalanced diet appears not to be confined to poor iron nutrition. In a report [26], the prevalence of anemia in North Korean females was about 34-36%, while that in South Korean females was 15-18%. The prevalence of protein-energy malnutrition was 31-40% in North Korean females aged 20 to 34 years, in contrast to 2-13% in South Korean females.

We acknowledge several limitations of our analysis, such as lack of data regarding serum iron, total iron binding capacity (TIBC), and erythrocyte protoporphyrin (EPP). Therefore, we need further studies, including iron, TIBC and EPP in children as well as in these age groups, because preschool children have shown high prevalence of iron deficiency/depletion. Since anemia can be caused by various nutritional deficiencies and pathological conditions, the specific characterization of anemia needs to be supplemented with precise nutrition and conditions.

In conclusion, this study shows that the prevalence of anemia and iron depletion was relatively high in women of reproductive ages, and there has been little change in prevalence compared with two decades ago. In addition, the prevalence of anemia is relatively high in elderly people regardless of gender. Considering the rapid increase in the older population, an intervention to prevent and treat anemia is imperative.

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