

Mean Hemoglobin Levels in Venous Blood Samples and Prevalence of Anemia in Japanese Elementary and Junior High School Students

Toru Igarashi¹, Yasuhiko Itoh¹, Miho Maeda¹,
Tsutomu Igarashi² and Yoshitaka Fukunaga¹

¹Department of Pediatrics, Nippon Medical School

²Department of Ophthalmology, Nippon Medical School

Abstract

Screening for anemia has been performed in schools in Japan for over 30 years. The long-term effect of the nuclear power plant disaster on the prevalence of anemia in school age children is unknown. This research was performed to evaluate the prevalence of anemia in school age children and to determine grade-level and gender-related reference hemoglobin (Hb) levels prior to the nuclear disaster. Data for this research were obtained from results of screening for anemia obtained by venous blood sampling in schools in 2002. Mean Hb levels were calculated for each grade level (elementary school grades 1–6 and junior high school years 1–3) and according to gender, and the prevalence of anemia was determined. In our research, Tokyo Health Service Association guidelines were used to determine reference Hb levels for anemia. We demonstrated that Hb levels in boys increased with age during childhood and adolescence (from 13.1 ± 0.7 g/dL in 7 year olds to 14.9 ± 1.1 g/dL in 15 year olds); in girls, Hb levels peaked at menarche (13.7 ± 0.8 g/dL in 12 year olds), decreasing slightly thereafter (13.4 ± 1.1 g/dL in 15 year olds). The prevalence of anemia was 0.26% in elementary school boys, 0.27% in elementary school girls, and 1.21% in junior high school boys. The prevalence of anemia in second- and third-year junior high school girls was lower than that in first-year junior high school girls. Among all junior high school girls, 5.73% had mild anemia. Iron-deficiency anemia is the commonest type of anemia in high school girls, secondary to the relative lack of iron due to menstruation, the growth spurt and exercise. Appropriate dietary therapy and treatment of anemia, together with education about the dietary prevention of anemia, are important to reduce the prevalence of anemia in high school students. When complete blood counts are performed in regions thought to be affected by the Fukushima nuclear power plant disaster, our report can serve as a reference during evaluation of Hb levels.

(J Nippon Med Sch 2012; 79: 232–235)

Key words: mean hemoglobin levels, anemia, elementary school, middle school, nuclear power

One year has passed since the accident at the Dai-ichi Nuclear Power Plant in Fukushima Prefecture.

During this time, blood testing has been performed in elementary and junior high school students aged

Correspondence to Toru Igarashi, MD, Department of Pediatrics, Nippon Medical School, 1–1–5 Sendagi, Bunkyo-ku, Tokyo 113–8602, Japan

E-mail: iga@nms.ac.jp

Journal Website (<http://www.nms.ac.jp/jnms/>)

Hemoglobin and Anemia in School Children

Table 1 Mean hemoglobin levels by grade level in elementary and junior high school student

	Male					Female		
	Grade	Age (years)	Number of students	Mean (g/dL)	SD	Number of students	Mean (g/dL)	SD
Elementary school	1	7	296	13.1	0.7	273	13.2	0.7
	2	8	471	13.2	0.8	470	13.2	0.8
	3	9	305	13.4	0.7	312	13.4	0.8
	4	10	472	13.5	0.8	463	13.5	0.8
	5	11	909	13.5	0.8	911	13.5	0.9
	6	12	573	13.7	0.8	587	13.7	0.8
Junior high school	1	13	769	13.8	0.9	796	13.3	0.9
	2	14	1,137	14.2	1.1	1,241	13.3	1.1
	3	15	651	14.9	1.1	843	13.4	1.1

7 to 15 years, as part of the health screening for residents living in the evacuation zone in Fukushima Prefecture. This included a red blood cell (RBC) count, hemoglobin (Hb), hematocrit, platelet count, and total and differential white blood cell (WBC) counts. In addition, for children living in areas with locally higher levels of radiation, whose parents may be concerned about the possibility of anemia due to low dose radiation, the number of children brought to hospitals for blood testing may be increasing.

In Japan, screening for anemia in school children using blood tests has been performed for more than 30 years. In 1994, with a partial revision of the Japanese law related to school health, screening for anemia in schools became mandatory, but testing did not necessarily have to be performed using collection of blood samples. Since then, the number of Japanese prefectures using blood tests for screening for anemia has been decreasing. Currently, in most regions, screening for anemia is performed by clinical examination. Specifically, this includes observation of skin color over the face, extremities and trunk and color of the palpebral conjunctiva and oral mucosa. However, since noninvasive screening methods for anemia may be inaccurate, evaluation by blood testing should be performed for more accurate diagnosis.

There are few reports of anemia testing by grade level and gender in Japanese elementary and junior high school students that were conducted prior to the nuclear power plant disaster.

We reviewed hemoglobin (Hb) levels from venous blood samples obtained for anemia screening in

elementary and junior high school students in 2002. In this report, mean Hb levels were determined at each grade level from the first grade of elementary school to the third year of junior high school. In addition, the grade-level prevalence of anemia in students was assessed. Our results can serve as reference values for future screening performed in other regions and contribute to more effective anemia screening.

Our data were obtained from a rural area. Screening was performed in all students in targeted grade levels who live in five nearby towns in Ibaraki Prefecture, adjacent to Fukushima Prefecture and 100 km from the center of Tokyo. Screening for anemia was performed in accordance with the "Ethical Guidelines for Epidemiological Research (2002)" of the municipal boards of education.

A total of 11,479 elementary and junior high school students (5,583 boys, 5,896 girls), ranging from the first grade of elementary school to the third year of junior high school, participated in blood testing. This included 3,026 elementary school boys and 3,016 elementary school girls (male : female = 1 : 1) and 2,557 junior high school boys and 2,880 junior high school girls (male : female = 1 : 1.13).

First, grade-level and gender-related mean Hb levels were calculated. Next, the number of students with no anemia (normal), mild anemia, and anemia by grade level and gender were evaluated.

As shown in **Table 1**, in boys, mean Hb level increased with grade level. In girls, mean Hb level increased during elementary school years. When the girls reached junior high school age, there was a

Table 2 Prevalence of mild anemia and anemia in elementary and junior high school students

		Male							
	Grade	Age (years)	Number of students	Normal Hb (n)	%	Mild anemia (n)	%	Anemia (n)	%
Elementary school	1	7	296	275	92.91	21	7.09	0	0
	2	8	471	446	94.69	22	4.67	3	0.64
	3	9	305	299	98.03	6	1.97	0	0
	4	10	472	452	95.76	18	3.81	2	0.42
	5	11	909	890	97.91	16	1.76	3	0.33
	6	12	573	567	98.95	6	1.05	0	0
Junior high school	1	13	769	715	92.98	48	6.24	6	0.78
	2	14	1,137	1,093	96.13	26	2.29	18	1.58
	3	15	651	636	97.7	8	1.23	7	1.08

		Female							
	Grade	Age (years)	Number of students	Normal Hb (n)	%	Mild anemia (n)	%	Anemia (n)	%
Elementary school	1	7	273	264	96.7	9	3.3	0	0
	2	8	470	446	94.89	24	5.11	0	0
	3	9	312	305	97.76	5	1.6	2	0.64
	4	10	463	450	97.19	13	2.81	0	0
	5	11	911	883	96.93	23	2.52	5	0.55
	6	12	587	575	97.96	11	1.87	1	0.17
Junior high school	1	13	796	741	93.09	42	5.28	13	1.63
	2	14	1,241	1,125	90.65	81	6.53	35	2.82
	3	15	843	769	91.22	42	4.98	32	3.8

n: Number of students

slight decrease in Hb levels¹. In girls, the increase in mean Hb peaked at the start of menstruation.

In 2001, the criteria for anemia were revised. Currently, the age-related reference Hb levels are: 5–11 years of age, ≤ 11.5 g/dL; 12–14 years of age, ≤ 12 g/dL; girls ≥ 15 years of age, ≤ 12 g/dL; and boys ≥ 15 years of age, ≤ 13 g/dL. Children with Hb levels below the reference level for the appropriate age are considered to be anemic².

Although there are no uniform criteria in Japan, in 1986, Yamamoto, in collaboration with the Tokyo Health Service Association, proposed provisional reference hemoglobin levels for anemia screening purposes that were used for evaluation in several regions. In this report, our evaluation uses their criteria³.

Based on these criteria, the following Hb levels correspond to anemia or mild anemia in elementary and junior high school boys and girls. In elementary school boys, 11.0–11.9 g Hb/dL is mild anemia, while ≤ 10.9 g Hb/dL is anemia. In first- and second-year

junior high school boys, 11.5–12.4 g Hb/dL is mild anemia and ≤ 11.4 g Hb/dL is anemia. In third-year junior high school boys, 12.0–12.9 g Hb/dL is mild anemia and ≤ 11.9 g Hb/dL is anemia. In girls of all grade levels, on the other hand, 11.0–11.9 g Hb/dL is mild anemia, and ≤ 10.9 g Hb/dL is anemia. Mild anemia means subclinical anemia, which is considered an early stage of anemia. Students diagnosed with mild anemia are recommended to increase their dietary intake of iron. Students diagnosed with anemia require evaluation and treatment by a doctor, in addition to increased dietary intake of iron⁴⁻⁶.

The prevalence of anemia in the students is shown in **Table 2**. The prevalence of anemia was 0.26% in elementary school boys, 0.27% in elementary school girls, and 1.21% in junior high school boys. Among junior high school girls, $\leq 93\%$ had normal Hb levels. In second- and third-year junior high school girls, in particular, approximately 1 in 10 were anemic or mildly anemic. In third-year

junior high school girls, approximately 4 in 100 had anemia. Among all the junior high school girls, 5.73% had mild anemia. In 1996, Yamamoto et al., using the same reference values as in our study, conducted a study in Tokyo and its suburban metropolitan areas in 5th grade elementary and 2nd year junior high school students, to evaluate regional differences in mean values and standard deviations of hemoglobin (Hb) in boys and girls. No particular trends were identified between Tokyo and the suburbs; similarly, we previously reported that there were no regional differences between the city and suburbs⁶.

Screening for anemia in schools has already helped to identify many students with anemia. The commonest type of anemia in female junior high and high school students who have started menstruation is iron-deficiency anemia⁴. A large amount of iron is required during adolescence because of the rapid growth in height at this time. In addition, because of the loss of iron due to the start of menstruation or with exercise, the body's iron requirements increase. Maeda pointed out a recent increase in the prevalence of anemia among females, primarily in junior high and high school students³.

Iron-deficiency anemia includes subclinical iron-deficiency anemia. Symptoms of anemia (headache, dizziness and decreased concentration, stamina, and memory) may be difficult to recognize because of their insidious progression. Anemia can cause

fatigue and school absenteeism. Improved dietary intake of the necessary vitamins and minerals and appropriate treatment will usually result in rapid improvement of the anemia, leading to an improved quality of life. Early detection of subclinical iron-deficiency anemia, lifestyle guidance, and treatment are all important in achieving this.

Acknowledgement: We wish to sincerely thank the municipal school boards of education for allowing us to review the results of anemia testing.

References

1. Igarashi T: Prevalence of anemia in Japanese students. An annual report, 2002; pp 36–39, JCS, Kashima, Ibaraki (in Japanese).
2. World Health Organization: Iron deficiency anemia: assessment, prevention, and control: A guide for programme managers 2001; pp 33.
3. Maeda M, Yamamoto M, Yamauchi K: Prevalence of anemia in Japanese adolescents: 30 years' experience in screening for anemia. *Int J Hematol* 1999; 69: 75–80.
4. Ross EM: Evaluation and treatment of iron deficiency in adults. *Nutr Clin Care* 2002; 5: 220–224.
5. Oski FA: Iron deficiency in infancy and childhood. *N Engl J Med* 1993; 329: 190–193.
6. Yamamoto M, Maeda M, Yamauchi K: A survey on Iron deficiency anemia. *Pediatrics of Japan* 1998; 39: 1219–1225 (in Japanese).

(Received, January 24, 2012)

(Accepted, April 2, 2012)