ACD 2022
The 8th
Asian Congress of Dietetics

PS-4-12

Blood Hemoglobin Levels and Related Factors in Japanese Children

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All the presenting author and co-authors have no financial conflicts of interest to disclose.

Objectives

The relationship between iron deficiency (anemia) in childhood and later development has been suggested by previous reports (Lozoff et al., 2006). However, there are few studies on the actual status of anemia in Japanese children have been conducted. In this study, we measured blood hemoglobin levels in Japanese children and their mothers using a newly developed non-invasive blood hemoglobin level measurement method to understand the actual situation and examine its related factors.

Methods

In October 2020, 132 children aged 1 year and 6 months to less than 6 years and their mothers were studied in Bunkyo Ward, Tokyo, and Kawasaki City, Kanagawa Prefecture. The hemoglobin levels in the blood of mothers and children were measured using Rad-67 (Masimo) (Fig. 1), and the information on the children's births and lifestyles was also collected by the questionnaire. The information of nutrient intake and food intake of mothers was collected by BDHQ (brief-type self-administered diet history questionnaire). The analyses were performed with IBM SPSS Statics Ver. 28. The correlation between hemoglobin levels of the children and the mothers was analyzed using Person correlation method and the possible factors related to hemoglobin levels of children were extracted performing Chi-squared test. Statistical significance was set at $p < 0.05$. Only 127 mothers' hemoglobin data were analyzed due to missing data or exclusion criteria conflict (pregnancy).

Fig.1 Rad-67 (Masimo)

Result (1): Blood Hemoglobin levels of the children and their mothers

The median hemoglobin concentration of the children was 12.55 g/dL, and **8% of the children had hemoglobin concentrations lower than the WHO criteria** (11 for 6-59 m.o. and 11.5 for 5-11 y.o.) for anemia (Fig. 2). **Children with anemia increase as age rises** (Fig. 3). The median hemoglobin concentration of the mothers was 13.75 g/dL, and 5.5% of the mothers had hemoglobin concentrations lower than the WHO criteria for anemia(Fig. 4). **The blood hemoglobin levels of mothers and children significantly correlated**, at r=0.285, p=0.001 (Fig. 5).

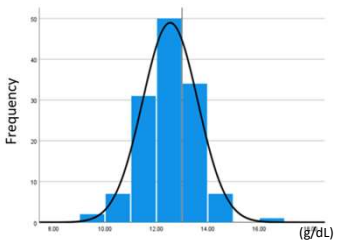

Fig.2 Hemoglobin concentration of the children

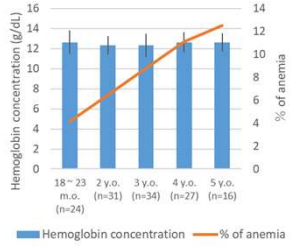

Fig.3 Difference of % of children with anemia between ages

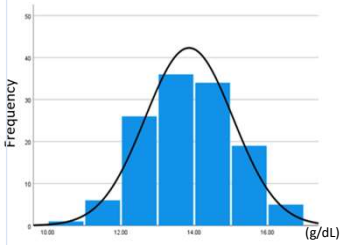

Fig.4 Hemoglobin concentration of the mothers

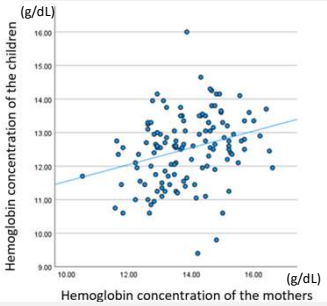

Fig.5 Correlation of the hemoglobin concentration between the mothers and the children

Result (2): Possible factors related to hemoglobin levels of children

Children with hemoglobin levels above the median were characterized by a marginally significantly higher percentage of follow-up infant formula intake (p=0.053) (Table1). There were no other differences between the two groups in terms of child sex, age, birth week, birth weight, pre-weaning nutrition method, frequency of meat intake, and iron supplementation habits other than follow-up infant formula and daytime childcare environment.

Table 1 Characteristics of the children with hemoglobin levels above and under the median.

	Total (n=132)		< Hemoglobin 12.55g/dL (n=60)		≥Hemoglobin 12.55g/dL (n=72)		χ^2	p value
	Frequncies	Percent (%)	Frequncies	Percent (%)	Frequncies	Percent (%)		
Sex								
Male	66	50.0%	27	45.0%	39	54.2%	1.100	0.294
Female	66	50.0%	33	55.0%	33	45.8%		
Age								
18-23 months	24	18.2%	11	18.3%	13	18.1%	2.757	0.599
24-35 months	31	23.5%	17	28.3%	14	19.4%		
36-47 months	34	25.8%	16	26.7%	18	25.0%		
48-59 months	27	20.5%	9	15.0%	18	25.0%		
60-71 months	16	12.1%	7	11.7%	9	12.5%		
Birth week								
< 32 weeks	2	1.5%	0	0.0%	2	2.8%	2.861	0.414
32-36 weeks	9	6.8%	5	8.3%	4	5.6%		
37-40 weeks	104	78.8%	49	81.7%	55	76.4%		
>40 weeks	17	12.9%	6	10.0%	11	15.3%		
Birth weight								
< 2500 g	14	10.6%	6	10.0%	8	11.1%	0.043	0.836
2500-3999 g	118	89.4%	54	90.0%	64	88.9%		
Feeding practice before weaning								
Exclusive breast-feeding	54	40.9%	24	40.0%	30	41.7%	0.071	0.965
Mixed feeding	71	53.8%	33	55.0%	38	52.8%		
Formula feeding	7	5.3%	3	5.0%	4	5.6%		
Iron supplementation*								
No	91	68.9%	41	68.3%	50	69.4%	0.019	0.891
Iron supplements	7	5.3%	4	6.7%	3	4.2%	0.407	0.523
Follow-up formula	8	6.1%	1	1.7%	7	9.7%	3.730	0.053
Iron-fortified drink	4	3.0%	1	1.7%	3	4.2%	0.696	0.404
Iron-fortified food	21	15.9%	12	20.0%	9	12.5%	1.376	0.241
Other	5	3.8%						
Meat intake								
≥ twice a day	20	15.2%	9	15.0%	11	15.3%	4.590	0.204
Once a day	48	36.4%	18	30.0%	30	41.7%		
4-6 times a week	53	40.2%	25	41.7%	28	38.9%		
1-3 times a week	11	8.3%	8	13.3%	3	4.2%		
Daytime environment								
Home	11	8.3%	6	10.0%	5	6.9%	0.400	0.527
Day-care/kindergarten	121	91.7%	54	90.0%	67	93.1%		

In addition, it was found that **the mothers of the children with hemoglobin levels above the median had more animal protein, fat, vitamin b2 and b6, and less carbohydrates** than the ones of the children with hemoglobin levels under the median (data not shown).

Conclusion

Of the children, 8% had hemoglobin levels below the criteria for anemia, and the blood hemoglobin levels of mothers and their children significantly correlated. There needs to be further study but the effectiveness of follow-up formula as an iron-supplementation method was potentially shown in this study. Furthermore, it was shown that dietary habit of mothers might be one of the factors affecting children's hemoglobin levels, which might be meaning that children's caregivers' dietary literacy or the meal quality at home is important for higher hemoglobin levels of young children in Japan.