THE SURVEY OF GROWTH AND DEVELOPMENT OF INFANTS AND
CHILDREN IN A REMOTE, LOW-ECONOMIC DISTRICT IN
THE MOUNTAINOUS CENTRAL KYUSHU, JAPAN

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In remote mountainous areas¹⁾²⁾³⁾⁴⁾⁵⁾, infants and children generally show retarded growth and development as compared with those in urban and rural districts. The authors had several opportunities to care for and to treat these underdeveloped infants and children living in the mountainous area, Yabe-Kuroki in Fukuoka Prefecture, when they participated in the summer medical activities of their School of Medicine.

This paper is to provide data on the growth and development of infants and children and to contribute to the improvement of infant nursing and the promotion of lunch preparation in the schools in mountainous areas.

MATERIAL AND METHOD

1. Surveyed area

The investigated area occupied 250 km² in extent and was on the average 500 meters above sea level. It was situated in the midst of one of the branches of the Central Kyushu Mountain Range and was 40 km south-east of Kurume City (Fig. 1 and 2). This area was divided into ten scattered primary school regions, which were 4 to 6 km away from the bus road, passing through the area along the river. The regions were located in the valleys or just below the summits of mountains. This area had a population of 28,509 in 1960, and the people lived by small-scaled farming, forestry and physical labor in each of the localities.

2. Materials

The material of the survey was 7,268 annual records of regular physical examinations of school children during the period from 1948 to 1959. As the objectives of further studies, four out of ten school regions were selected according to consultation with a pediatrician and the local communities in this district. Involved were 233 school children and 611 preschool children, one to five years of age. The children received physical examinations, and sera from all of the

school children and 158 of the younger children were obtained in 1959.

Fig. 1. Geographic Position of Surveyed Area.

Fig. 2. Yabe-Kuroki Area in Fukuoka Prefecture.

RESULTS

1. Beginning and ending months of weaning

Mothers usually began to wean their infants at six months of age, being one month later than the average in Japan (Tab. 1). But the ending month of weaning was prolonged to more than 18 months of age among half of the infants in this area, while the majority of infants were completely weaned by at least one year and a half in Japan (Tab. 2). Through a physical examination of weaning infants it was revealed that 24 % were insufficient in weight and were under-

TABLE 1
Beginning Months of the Weaning

Area		<5	5	6	7	8	9	10	11	12<
Yabe, Kuroki	No.	1	2	32	21	35	6	10	5	19
	%	0.7	1.5	24.4	16.0	26.7	4.6	7.6	3.8	14.5
Japan	No.	199	379	287	549	329	102	110	37	91
	%	7.5	14.2	29.8	20.6	12.3	3.8	3.9	1.4	3.4
Fukuoka pref.	No.	19	52	105	118	73	24	33	11	44
	%	4.0	10.8	22.0	24.6	15.2	5.0	6.9	2.3	9.2

nourished, although undernourishment is found in less than 10 % of rural districts in Fukuoka Prefecture (Tab. 3).

TABLE 2
Ending Months of the Weaning

Area		6	7	8	9	10	11	12	13	14	15	16	17	18<
Yabe, Kuroki	No.	0	0	0	0	1	4	17	4	4	11	1	4	33
	%					1.2	5.0	21.5	5.5	5.5	13.5	1.2	5.0	41.8
Japan	No.	8	4	27	20	53	53	178	56	75	53	35	26	88
	%	1.1	0.5	3.8	2.8	7.5	7.5	25.2	7.9	10.6	7.5	4.9	3.6	12.4
Fukuoka pref.	No.	2	1	5	3	11	10	39	16	22	20	10	8	26
	%	1.1	0.5	2.7	1.6	6.1	5.5	22.1	8.9	12.2	11.1	5.5	4.4	14.5

TABLE 3
Growth and Development of Weaning Infants in the Investigated Area

Nutrition	better	good	moderate	undernourished	total
No. of infants	21	12	96	41	170
%	12.3	7.1	66.5	24.0	

2. Length and weight of preschool children

The average length attained 98.6 % and 99.5 % and the average weight 96.6 % and 96.1 % of the national averages in boys and girls, respectively (Fig. 3, 4). The growth in length and weight became slower at four years of age in both boys and girls.

3. Length, Weight and Rohrer index of school children

During these eleven years from 1948 to 1959, no differences were found in the annual increasing rates of length and weight between the area averages and the national averages for both sexes. That is, the rates of length were 4.4 % (4.4 %) and 4.3 % (4.6 %) and those of weight 10 % (12 %) and 11 % (11 %) in boys and girls, respectively, the numbers in parentheses showing the national averages (Fig. 5, 6, 7, 8). Although there has been a slow increase in stature from 1.8 % to 0.2 % in boys and from 4.8 % to 1.2 % in girls, and that in weight from 9.8 % to 1.7 % in boys and from 7.8 % to 7.7 % in girls in these eleven years, the growth in length and weight were retarded by 2 % and 3.5 % in both sexes in comparison with the national averages.

Their Rohrer indices showed higher values in the upper school grades, and they began to show the typical stature of mountainous districts (Fig. 9).

Fig. 3. Average Growth Curves in Length 1959.

4. Lunch

The dryness of skin, anemia, angular stomatitis and accentuation of the pulmonary second heart sound were frequently observed among these children. Since undernourishment seemed to prevail among school children at the beginning of the survey, an attempt was made to study their diet. To be certain of the daily diet of pupils, the authors examined without previous announcement the home-prepared lunch which the pupils used to bring to school everyday as was the usual manner of school children formerly in the rural districts. The lunches of 232 children were weighed and examined as follows:

1) Qualitative analysis of lunch food

Basic foodstuffs were rice and wheat, and they were usually mixed in a pro-

Fig. 4. Average Growth Curves in Weight, 1959.

portion of 65 parts of rice to 35 parts of wheat. Usually in each of the lunches vegetable and animal foods were added in small amounts. 82 % of these added foods were simple preserved preparations. The preserved vegetables were mainly pickled radish, fried pickled vegetables and salted tangle, and the preserved animal foods were mainly fish powder, roasted or fried fish paste, soy cooked sea slug, slices of bonito, sausage and salted whale (Tab. 4).

2) Quantitative analysis of lunch food

In Tab. 5, total calories, protein, fat and carbohydrate intake are presented separately according to the grades of school. The amount of total calories ranged from 508 to 570 Cal, with an average of 518 Cal, and this covered 86% of the caloric requirement for a standard school lunch. Ninety-four per cent of the total calories was derived from the basic foodstuff. The protein intake was 12 g on the average and it was half the allowance of the standard lunch regimen for Japanese school children. The protein of animal origin was predominantly supplied by preserved fish preparations and it amounted to only 2 g. The remaining proportion of protein was obtained from rice and wheat. The fat intake was 2.6 g on the average and it was a quarter of the standard allowance of the lunch

Fig. 5. Average Increment by Year in Length During 1948 to 1959 (Boys).

TABLE 4

Constitvnts of Lunch Food of School Children

Primary schools		H	O	O	Total	%
Food						
Rice		18	5	1	24	10.5
Wheat & Rice		73	72	63	208	89.5
Vegetable foods	Preserved foods	52	60	31	143	81.8
	Cooked foods	12	13	8	33	18.2
Animal foods	Praserved foods	60	30	10	100	82.0
	Cooked foods	7	13	2	22	18.0

Fig. 6. Average Increment by Year in Length During 1948 to 1959 (Girls).

TABLE 5

Total Calories and Constituents of Lunches of Pupils

Grade of School	Total Cal	Animal Protein g	Vegetable Protein g	Total Protein	Prot/kg	Fat	Carbohy- drate	Carboh/ Tot. Cal.
1	493	2.63	9.25	11.88	0.646	3.0	107	85
2	520	1.87	10.15	12.02	0.584	2.3	114	87
3	533	1.74	9.76	11.50	0.519	2.8	119	87
4	566	1.68	10.28	11.96	0.495	2.3	108	88
5	566	1.42	10.36	11.78	0.457	2.4	115	88
6	566	1.54	9.96	11.50	0.391	2.4	121	88
Total	541	1.81	9.97	11.78	0.517	2.5	114	87

regimen.

This investigation revealed that the protein and fat intake in everyday lunches were deficient in quantity and unbalanced in quality.

Fig. 7. Average Increment by Year in Weight During 1948 to 1959 (Boys)

5. Protein and fat content of sera of children

As was previously described, the factor responsible for latent malnutrition invariably persisted among these children. Three hundred ninety serum samples were collected from preschool and school children just before lunch time. The total protein in the serum was 6.6 g per 100 ml in younger children and 7.3 g per 100 ml in school children, showing the lower values of the normal range of serum protein. Protein fractions of serum were determined through paper electrophoresis. Albumin, α_1 -, α_2 -, β - and γ -globulin contents of serum were, respectively, 3.83 g, 0.22 g, 0.65 g, 0.78 g and 1.23 per 100 ml in preschool children, and 3.99 g, 0.32 g, 0.65 g, 0.77 g and 1.51 g in school children (Tab. 6). There was an indication from the electrophoretical analysis that hypoalbuminemia and hypergammaglobulinemia existed in mild degree and the ratio of albumin to globulin decreased slightly.

Total fat varied from 590 mg to 612 mg, with an average of 613 mg per 100 ml in preschool children and from 635 mg to 713 mg, with an average of 667 mg per 100 ml, in school children. These averages attained 80 % of the normal values of the fat content of serum. The content of α -lipoprotein in percentile was

Fig. 8. Average Increment by Year in Weight During 1948 to 1959 (Girls)

TABLE 6

Total Protein and Protein Fractions A/G Ratio of Serum

Age in year	n	Total Protein	Albumine	α_1 -G1	α_2 -G1	β -G1	γ -G1	A/G
1-2	17	6.82	3.93	0.26	0.73	0.78	1.05	1.44
2-3	33	6.79	3.17	0.25	0.75	0.82	1.19	1.28
3-4	45	6.74	3.69	0.26	0.74	0.85	1.31	1.26
4-5	33	6.43	3.60	0.20	0.67	0.67	1.30	1.26
5-6	25	6.74	4.01	0.18	0.61	0.61	1.28	1.49
6-7	31	7.29	4.14	0.27	0.68	0.84	1.39	1.34
7-8	41	7.31	3.90	0.32	0.69	0.84	1.57	1.19
8-9	44	7.35	4.11	0.31	0.63	0.83	1.53	1.53
9-10	40	7.04	3.61	0.35	0.63	0.89	1.57	1.06
10-11	31	7.20	3.99	0.28	0.62	0.85	1.53	1.32
11-12	45	7.52	4.15	0.25	0.64	0.87	1.60	1.30

Fig. 9. Graphs of Rohrer Indexes of School Boys and Girls.

approximately normal at 36.6 % and 34.4 %. That of β -lipoprotein in percentile was slightly decreased to 44.8 % and 38.9 % in preschool and school children, respectively. The ratio of β -lipoprotein to α -lipoprotein was lowered to 1.44 and 1.32 respectively, in both groups of children in contrast with the normal values 1.90 (Tab. 7).

TABLE 7
Total FAT and Lipoprotein in Percent in Serum

Age in year	n	Total fat	n	α -LP	β -LP	γ -LP	β/α
1-2	14	637	12	38.9	48.7	12.9	1.46
2-3	30	590	26	33.0	44.2	18.7	1.38
3-4	37	601	26	37.0	48.7	15.2	1.59
4-5	29	612	29	36.2	39.8	23.8	1.17
5-6	19	611	21	34.6	37.0	27.7	1.19
6-7	27	641	17	30.3	43.7	25.8	1.35
7-8	37	662	27	33.2	43.9	22.8	1.39
8-9	38	635	40	39.7	37.1	24.2	1.08
9-10	39	660	32	36.0	43.8	20.1	1.42
10-11	26	713	24	32.9	43.1	23.8	1.40
11-12	24	674	38	35.5	41.3	25.8	1.31

COMMENTS

Since a gradual gain in height and weight was continuously observed for eleven years and the annual increasing rate showed the same pattern as the national average, the acceleration phenomenon of growth took place even in the remote mountainous area. Not only the records of regular physical examinations, but also recent investigation, however, revealed retardation of growth compared to the national average. Among the factors influencing growth, malnutrition should naturally be taken into consideration.

The prolongation of the weaning period and an inadequate diet invariably affected the growth and development of infants. The home-prepared lunches of the pupils were deficient in protein and fat, and the home diet would not, therefore, differ much from the lunch food. Since their nutritional requirements mainly depend upon rice and wheat, there consequently would result an insufficiency of protein and fat intake in both proportion and amount, even if daily soya would partially compensate for this deficit. In reality, hypoalbuminemia and hypolipemia are frequently detected throughout childhood and they reveal the existence of latent malnutrition, sometimes showing the clinical signs of it.

From this survey, it is evident that children are often suffering from latent malnutrition and their growth is in greater or lesser extent affected in the remote mountainous area⁹⁾.

The communities have discussed these actual aspects of child growth and nutritional state, and school lunch preparation has been realized in all of the primary schools within one year and a half. Instruction in infant nursing took place very often in each locality.

SUMMARY

We have investigated the infants and children in the remote, low-economic area in the mountainous Central Kyushu through recent records of annual physical examinations and the actual examination of their lunch foods and blood sera. Although the acceleration phenomenon observed among these children, they showed the retarded growth in comparison with the national averages. Prolonged weaning affected considerably the growth and development of infants. The examination of the lunches of school children revealed the deficiency in the nutritional supply particularly in protein and fat because their daily diet depends mainly upon the basic rice and wheat. Subsequent hypoalbuminemia and hypolipemia revealed that latent malnutrition prevailed among the infants and children studied. In order to improve child growth, the communities have realized school lunch preparation and have promoted instruction in infant nursing within one year and a half from this survey.

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