The nutritional status of pre-school children in poor rural areas of China

Chang Ying*, Zhai Fengying*, Li Wenjun*, Ge Keyou*, Jin Daxun* and Mercedes de Onis§

*Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine, Beijing, China; §Nutrition Unit, World Health Organization, Geneva, Switzerland.

Described are the main findings of the first large-scale nutrition monitoring project carried out over a 4-year period in China. The nutritional status of nearly 10 000 preschool children in 18 comparatively poor rural areas in seven provinces was followed each year over the period 1986–89 in order to identify their major nutritional problems and improve their growth and development. Physical measurements were made and dietary surveys and biochemical tests were performed on a subsample of the children. The proportion of stunted and underweight children was far higher than the national average. Based on the possibilities offered by local circumstances, the prevalences of stunting and underweight were lowered and anemia greatly reduced. Along with the progress in nutrition monitoring, major efforts were made to train health workers, as well as to encourage increased production of green vegetables, poultry, and small livestock. The wealth of information collected and the experience gained may serve as a baseline record, the project currently being expanded to cover 100 counties throughout China.

Introduction

Along with the steady growth in agricultural production and the rapid development of the national economy in recent years, the standard of living for the Chinese people has been raised significantly. A national nutrition survey in 1982[1] showed that the problem of food and clothing has basically been solved and the nutritional status has been greatly improved. On the other hand, the survey also indicated that here were still shortcomings in the diet of pre-school children as the dietary intake of protein, calcium and riboflavin was inadequate and the energy intake was only 90% of the required amount.

It is also known that development in China is not totally balanced and that due to the vastness of the territory and the differences in circumstances there are certain localities where height and weight are less than the standard for normal children in China. Recognizing these problems, the Chinese government launched a project aimed at evaluating the nutritional status of the children, the major existing problems and their trend of development in these disadvantaged areas. Furthermore, the project explored measures for improvement in line with local conditions so as to improve the nutritional status of the children, to promote their growth and development, and to reduce the prevalence of nutrition deficiency diseases, while at the same time training nutrition personnel and accumulating working experience.

Methods

Conducted for the first time in China, the five-year project (1985–89) for monitoring and improving the nutritional sta-

tus of pre-school children, is one of the collaborative projects between the Ministry of Public Health and UNICEF, carried out by the Institute of Nutrition and Food Hygiene in collaboration with the Chinese epidemic prevention stations in seven provinces.

In order to assess growth problems in rural areas, 18 relatively poor survey sites (townships) with an annual income per capita between 200 and 500 Chinese yuan (equivalent to US$55–135) were selected according to the economic and geographical conditions, communication, population structure, dietary habits and standard of living in the provinces of Guangdong, Jiangxi, Guizhou, Sichuan, Gansu, Hunan and Hubei. The average income of rural population for China at that time was 398 yuan, equivalent to US$107. A pilot study was first conducted in Jiangxi Province in 1985, and formal work began in the other six provinces in 1986.

The survey subjects included 500 pre-school children under 6 years of age from all or a number of villages at the survey sites. Physical measurements (height, weight and arm circumference) were taken every year (1986–89) from May to June from nearly 10 000 children and a physical examination for nutrition deficiency diseases was performed. A subsample of the children examined were interviewed using the 24-hour recall method to assess their diet, and a quarter of the total number of children had a blood sample taken for biochemical testing. Data were also collected on socioeconomic conditions.

Table 1. Prevalence of moderate and severe malnutrition (1986–89).

Indicator	1986			1987			1988			1989		
	n	<-2 SD[a] (%)	<-3 SD (%)	n	<-2 SD (%)	<-3 SD (%)	n	<-2 SD (%)	<-3 SD (%)	n	<-2 SD (%)	<-3 SD (%)
Weight-for-age	9984	27.5	4.0	9805	28.8	4.8	8814	26.0	4.3	9144	24.4	3.8
Height-for-age	9911	42.9	14.5	9739	44.3	15.6	8753	42.0	14.4	9083	41.8	14.2
Weight-for-height	9921	2.7	0.3	9741	2.9	0.5	8757	2.5	0.3	9076	2.2	0.5

[a] % of children below -2 or -3 standard deviations of the WHO/NCHS international reference median values.

Body weight was measured with a beam-balance platform scale with a maximum capacity of 50 kg and an accurate read-out of 25–50 g; children wore only light underwear or clothing of known weight which was subtracted from the total. Infants unable to sit up were weighed in a container of known weight. All scales were adjusted to zero before usage. A recumbent measuring board was used for children under 3 years of age and a stadiometer for children above 3 years. Measurements were made to the nearest 0.1 cm. A spectrophotometer or a miniature hemoglobin photoelectric colorimeter, which uses a cyanomethemoglobin method, was used to measure hemoglobin concentration.

The results presented in this paper for all growth data are interpreted using the international growth reference[2]. Height-for-age, weight-for-age and weight-for-height Z-scores were calculated following WHO recommendations[2,3].

Since 1985 nutrition interventions were implemented at all surveillance sites. The interventions varied according to the specific situation in the various provinces, but in general included the following aspects:

• training of more than 11 000 field workers in different nutritional aspects
• control projects for anemia in children (mainly fortified foods and iron supplements for pregnant woman
• promotion of home gardening and animal raising by increasing the varieties of and area for vegetable crops, increasing the production and consumption of soya beans, and developing family animal husbandry and fruit tree cultivation popularization of knowledge on nutrition through mass media such as radio, bulletin boards, slides, films and posters. Breast-feeding was advocated and mothers received instructions on good baby-feeding practices
• dissemination of knowledge on health with the aim of improving the rural health situation and controlling prevalent diseases in children
• establishment of township committees for the management of the work concerning nutrition.

The implementation of all or part of these measures during the study period was expected to have a positive impact on child nutritional status indicators.

Results

Physical growth and development

Height-for-age. Low height-for-age (H/A) or stunting signifies slowing in skeletal growth and is a main indicator of long-term nutritional experience or growth impairment caused by malnutrition in the past. Stunting is frequently found to be associated with poor overall economic conditions, chronic or repeated infections, as well as inadequate nutrient intake[3]. The prevalence of stunting among the children at the surveillance sites was >40% for all years, with a
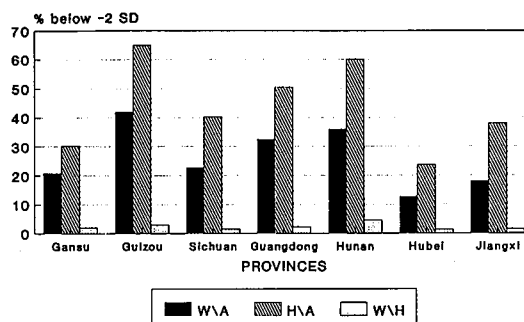

Fig. 1. Nutritional status of pre-school children in selected poor rural areas of China. Regional differences, 1989.

prevalence of severe stunting (below -3 SD from the international reference median) of around 14% (Table 1). This prevalence was considerably higher than the national average for rural areas (36%) as estimated by the 1987 national growth survey[4]. As can be seen from Figure 1, there was a large variation between provinces. The prevalence was highest among Guizou, Hunan and Guangdong Provinces sites, being >50%. Hubei Province had the lowest prevalence of stunting, 23%.

Figure 2 shows that the height-for-age Z-score distribution for the Chinese children is similar for both boys and girls. Compared with the reference population, the distributions for both sexes are shifted to the left. The variance, as reflected by the spread of the distribution for each sex, is similar to that of the reference distribution, suggesting that most children share similar nutritional and socioeconomic conditions. The leftward shift in the distributions away from the reference population does not appear to be the result of a subgroup of children who were unusually short.

The prevalence of stunting among children of different ages for the different years is shown in Figure 3. As can be seen, the pattern of stunting by age group is similar in all four years with a steep rise in prevalence during the first year of life up to the 40–50% range and a levelling off afterwards.

Weight-for-height. Low weight-for-height or wasting indicates a deficit in tissue and fat mass compared with the amount expected in a child of the same height or length, and may result either from failure to gain weight or from actual weight loss. One of the main characteristics of wasting is that it can develop very rapidly, and under favourable conditions can be restored rapidly. Thus, low weight-for-height is commonly used to assess acute or recent malnutrition[3].

The prevalence of wasting among the surveyed children is within the range of that expected for the reference population, <3% for all four years (Table 1), indicating that no significant level of acute malnutrition exists. However, the distribution
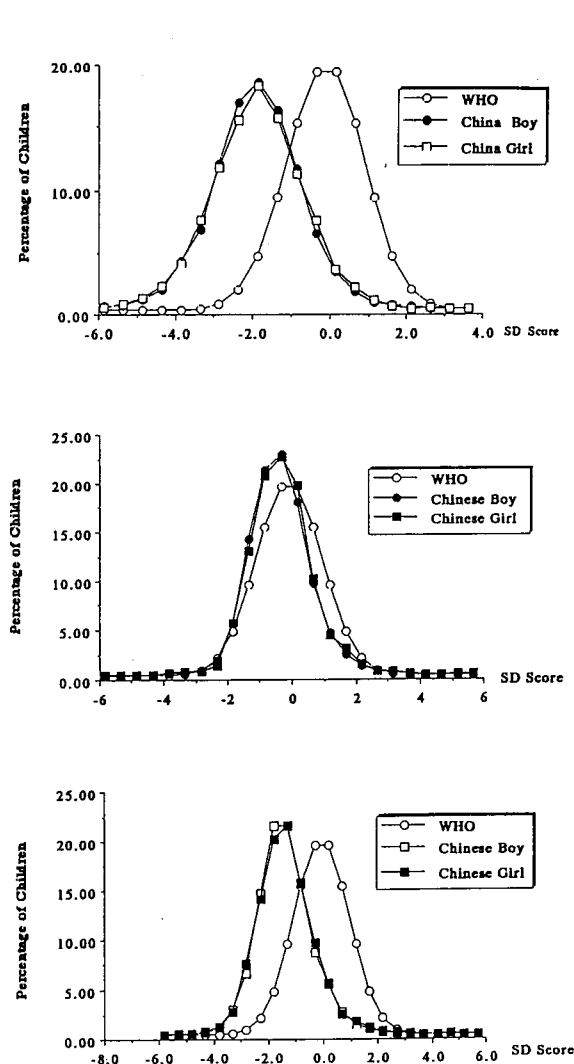
Fig. 2. Z-score distribution for (a) height-for-age, (b) weight-for-height, and (c) weight-for-age of Chinese children compared to the international reference, 1989.

of Z-scores, similar for both sexes, shows a slight leftward shift from the international reference population (Figure 2).

There was a lack of substantial acute undernutrition in all seven provinces (Figure 1), although as with the pattern of low height-for-age, the prevalences in the Hunan and Guizou Provinces were generally higher than those in other provinces. The prevalence of wasting among children of different age groups was quite different from that for height-for-age; the prevalence of wasting was greatest between 6 and 24 months of age, and tended to decrease later on (Figure 3).

Weight-for-age. Low weight-for-age or underweight is an index that combines the information of height-for-age and weight-for-height. Thus, this indicator alone cannot provide adequate information to distinguish between wasting and stunting; however, for this very reason it may remain an appropriate index for certain applications.

The prevalence of low weight-for-age among the surveyed children was in the range of 24–28% for all years, higher than the national average for China (21.3%) and also somewhat higher than the average for rural areas (23.7%)[4] with prevalences above 30%. Hubei Province had the lowest prevalence of low weight-for-age, 12.7% (Figure 1).
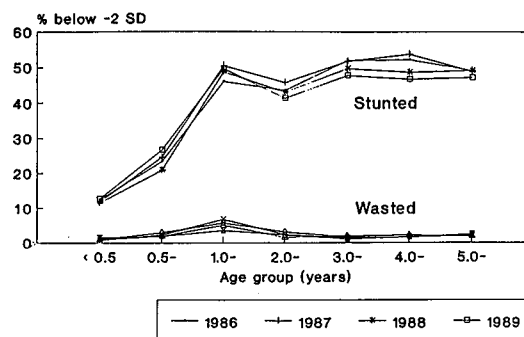

Fig. 3. Nutritional status of pre-school children in selected poor rural areas of China. Prevalence of malnutrition by age group.

The distribution of Z-scores for weight-for-age is very similar to that based on height-for-age, showing an overlapping leftward shift from the reference population of the Chinese boys and girls surveyed (Figure 2). The pattern of low weight-for-age by age group is also similar in all four years to that shown in height-for-age, with a steep rise in prevalence during the first year of life up to the 30–35% range, after which it drops slightly and stays at the level of 25–30%.

Table 2 presents the change over time in the prevalence of the three anthropometric indicators. A consistent trend of improvement over time can be seen for all three indicators.

The relationship between current nutritional status and family income, parental education and birth order was summarized in Table 3. Income per capita shows a strong negative correlation with the indicators of nutritional status, ie the higher the income, the lower the prevalence of stunting and underweight. The opposite is observed for illiteracy where a strong positive correlation with nutritional status is shown meaning the lower the parents' level of education, the larger the proportion of children stunted or underweight. Interestingly enough, the relationship between the prevalence of stunting and underweight and the percentage of firstborns among the children surveyed at the various sites is inversely proportional, the correlation coefficient being –0.63 and –0.68, respectively. In other words, the larger the number of firstborns surveyed at each site, the lower the percentage of children with low height-for-age and weight-for-age. The opposite may be observed in the case of second or later births where the prevalence of stunting and underweight was positively correlated with the percentage of second or later births among the children surveyed (r=0.65 and r=0.69 respectively).

Anemia

With hemoglobin less than 11.0 g/dl as the criteria for diagnosis, the prevalence of anemia among the various age groups over the years is shown in Table 4. Poor iron nutrition status was a serious problem in the study population with the highest prevalence among the 6-month and 1-year age groups. In children older than a year, the prevalence gradually drops with the increase in age. Most of the anemia cases were mild, with very few cases of severe anemia (less than 8 g /dl).

The prevalence of anemia among children in the seven provinces showed a downward tendency over the years. A comparison of the prevalence in 1986 and 1989 reveals that there was a statistically significant decrease of anemia during the 4-year period in all age-groups (Table 4).

Table 2. Relative change over time (1986–89) in the prevalence of wasting, stunting and underweight by age group.

Age group	Wasting	Stunting	Underweight
<0.5	+87.5	+1.6	–26.8
0.5–0.99	–16.7	+14.2	+1.3
1.0–1.99	–47.8	+8.1	–13.1
2.0–2.99	–4.2	–5.3	–10.2
3.0–3.99	–23.1	–8.3	–16.1
4.0–4.99	0.0	–10.5	–17.5
5.0–5.99	+20.0	–3.9	–7.2
Total	–18.5	–2.6	–11.3

Table 3. Correlation coefficients between children nutritional status and related factors.

	Income	Illiteracy	Birth order	
Height-for age				
Male	–0.51*	0.72*	–0.63*	0.65*
Female	–0.53*	0.70*		
Weight-for-age				
Male	–0.49*	0.59*	–0.68*	0.69*
Female	–0.41*	0.45*		

*P<0.05

Dietary survey

The results of the dietary survey indicate that at 4 months of age only 5% of the infants were bottle fed. With the exception of four study sites in Guangdong and Hunan Provinces, exclusive breast feeding rates ranged between 64–93%. Some areas of these two provinces have a high mixed feeding rate due to traditional custom. This may play some role for the high prevalence rate of wasting children in these areas.

Most children aged 6–12 months had not been completely weaned. The most common supplementing foods in this age-group were rice and wheat flour, followed by sugar. Only in a few study sites some amounts of animal milk and egg were used. Thus inadequate nutrient intake may be related to the high prevalence of malnutrition within this age-group. For most children in the 1 year age-group, the amount of supplementary food was larger than that for infants aged 6–12 months, but it was mainly the amount of cereals that was increased.

The food intake in children aged 2–5 years still consisted mainly of cereals (rice and wheat). There was also a certain amount of potatoes or sweet potatoes and a small amount of soybeans and bean products are available in most areas. The intake of vegetables at the various sites ranged from an average of less than 10 g per to 250 g per day. The average intake of fruit for each age group was 22–27 g per day. Hardly any milk was given to over-2-year-olds. The average intake of eggs for the various age groups was 12–16 g per day, that of meat 12 g per day, and that of fish 5 g per day.

In general, 75–89% of the energy of children aged ≥2 years was provided by begetable sources, of which cereals accounted for 66–81%; only 5–14% was obtained from foods of animal origin. Cereals were also the major source for protein in the diet of children, accounting for 60–84%; 7–23% was provided by foods of animal origin, while the proportion provided by soya bean protein was relatively low.

The results of the study show that the energy intake of the children was adequate, 98–102% of the Chinese recommended aily intake (RDA), but that intake of protein, calcium, vitamin A, and riboflavin was only 76–81%, 23–29%, 42–75%, and 50–56% of the RDA value, respectively.

Discussion

Children at the surveillance sites were both shorter and lighter than the international reference population; they also had higher prevalences of stunting and underweight than the national averages for China[27]. This is in agreement with data from other parts of China, indicating that beginning at the weaning period, the growth of rural children lags behind that of their urban counterparts[5,6,27]. However, there was a lack of significant acute malnutrition in all seven provinces and the prevalence of wasting is within the range of that expected for the reference population. The combination of high prevalence of stunting with no evidence of wasting is a common observation in many populations.[7]

There is now sufficient 'evidence demonstrating that the growth of children of high socioeconomic levels within a poor country is comparable to that of the international reference population, even though the children in the general population of these countries are markedly stunted[8–10]. Also, reports of significant secular improvement of childhood growth and adult height from Asian countries[11], and studies showing dramatic improvements of growth of Asian children exposed to improved environmental or nutritional circumstances[12], have questioned the role of genetic factors in the differences among populations in childhood growth. We believe the high prevalence of stunting among the study population is related to environmental factors, mainly nutrition and slower socioeconomic development in these areas, and not to differences in growth potential of Asian children. This is supported by the strong negative correlation shown between nutritional status indicators and income and parents' level of education, and by the growth pattern of other more developed areas of China.

The fact that the prevalence of stunting in the surveyed children rises steeply during the first year of life, to keep steady afterwards in the 40–50% range, confirms the importance of infant nutrition and supports the hypothesis that generalized growth failure is an active process in the 6 to 18-month period and is essentially irreversible after that time[13]. It also indicates that future efforts for nutritional improvement in rural areas of China should focus on children around a year old[14]. This is very important since longitudinal and cross-sectional studies have indicated that growth failure in infancy is not recouped in later childhood and adolescence[15–19].

Table 4. Percentage age-specific prevalence of anemia (hemoglobin concentration < 11 g/dl) by years.

Age group (years)	1986		1987		1988		1989	
	n	(%)	n	(%)	n	(%)	n	(%)
0.5–0.99	704	62. 3*	709	60.2	725	54.2	760	51.0*
1.0–1.99	1051	49.9*	1017	45.5	1225	42.6	1164	41.4*
2.0–2.99	908	37.7*	831	33.7	1149	28.3	1083	27.5*
3–5.99	1929	28.4*	1961	25.8	2576	18.8	2283	17.6*

*P<0.01.

The implementation of the different nutrition interventions could have had a positive impact on the nutritional status of the children at the surveillance sites. The proportion of wasted, stunted and underweight children in the age groups above 2 years was reduced by varying degrees between 1986 and 1989. As could be expected, weight-for-height is the indicator that shows the greatest relative improvement, although its pre-existing overall low level did not leave much room for improvement. Nonetheless, there is a decrease in prevalence from 6.7% in 1986 to 3.5% in 1989 (a 50% reduction) in the group of children of 1 year of age, where the baseline prevalence of wasting was the highest. The small improvement in the prevalence of stunting in such a short period was expected since linear growth is a slower process, and even with a favourable environment it takes a relatively long time to show improvements[3].

The high prevalence of anemia among infants and young children is a problem which should be given serious consideration. A main contributory cause could be the poor availability of iron from the Chinese cereal-based vegetarian diets, but the relative importance of other factors requires investigation. However, the significant downward tendency over the years in the prevalence of anemia among the children in the study sites may be related to the implementation of the projects to overcome this condition. The findings suggest that health promotion and health education, integrated with the supply of fortified foods and drugs, may have a considerable effect on prevention and treatment. A population-based prevention programme is required, especially during the first two years of life.

The results from the dietary survey clearly indicate that there is a need for timely and adequate weaning foods for the breast feeding infants above 6 months of age. Attention should be paid to increasing the intake of foods of animal origin, such as eggs and milk. In children aged 2 years and above efforts should be made to increase the intake of protein, calcium and riboflavin. Under existing conditions, increasing the intake of soybeans, soybean products and eggs may be a way to improve the situation. Also further exploration of the insufficient intake of vitamin A and ways to improve the diet should become a subject for studies in the future.

The few published studies on growth in vegetarian children[20-24] provide some evidence that a vegetarian diet, when used early in life, may pose nutritional deficiencies that could potentially disrupt growth for infants and small children; and that young children placed on extreme vegetarian diets may experience growth stunting[25]. Also it has been shown that children who had changed from a pure vegetarian diet to a less restrictive diet had experienced a tremendous growth spurt over a 2-year period following the change in diet[24]. As Jacobs & Dwyer point out[26], both height and weight differences, but particularly height, are most affected in the early stages of growth in children raised on extreme vegetarian diets.

Nutritional requirements during crucial stages of development must be met in order to ensure optimal growth of Chinese children living in rural areas. A variety of measures to improve nutrition should be explored in these areas, paying attention to the problem of maternal and infant nutrition with pregnant women, breast-feeding mothers and children 0–3 years old as priority groups for improvement.

Embodying a mass of surveillance information and specific experience, this project may serve as a baseline record of the current nutritional status of children in poor rural areas of China, as well as a useful reference for the implementation of work of its kind in other areas. The improvement over the 4-year period in the general nutritional status based on assessment of growth and anemia is encouraging and can be regarded as a major achievement. Nevertheless, the continuation and expansion of what has been achieved till now represents a big challenge for the country. At present, a second phase of the collaborative project is on-going covering the period 1990–94 and the work sites have been expanded to include a total of 100 counties throughout the 27 provinces and autonomous regions of the country.

References

1   Chen CM. The national nutrition survey in China, 1982: summary results. Food Nutr 1986; 12:58–60.

2   Measuring change in nutritional status. World Health Organization: Geneva, 1983.

3   WHO Working Group. Use and interpretation of anthropometric indicators of nutritional status. Bull WHO 1986; 64: 929–941.

4   The third national growth and development survey of children in China, 1987. WHO Global Anthropometry Data Bank. World Health Organization: Geneva, 1992.

5   Zhang X, Huang Z. The second national growth and development survey of children in China, 1985: children 0 to 7 years. Ann Hum Biol 1988; 15:289–305.

6   Roujia C, Jingqi C, Huiti H, et al. Physical growth of Chinese children from birth to 6 years old in urban and rural areas in 1985. J Trop Pediatr 1989; 35:255–262.

7   Victora C. The association between wasting and stunting: an international perspective. J Nutr 1992; 122:1105–1110.

8   Graitcer PL, Gentry EM. Measuring children: one reference for all. Lancet 1981; ii:297–299.

9   Monteiro CA, Benicio MH, Gouvea NC. Growth and nutritional status of Brazilian children: findings from the 1989 National health and Nutrition Survey. Country Studies on Nutritional Anthropometry Series. Doc WHO/NUT/91.1. Geneva: World Health Organization, 1991.

10   Agarwal KN, Agarwal DK, Benakappa DG, et al. Growth performance of affluent Indian children (under-fives). Growth standard for Indian children. Scientific Report #11. New Delhi: Nutrition Foundation of India, 1991.

11   Eveleth PB, Tanner JB. Worldwide variation in human growth. New York: Cambridge University Press, 1991.

12   Yip R, Scanlon K, Trowbridge F. Improving growth status of Asian refugee children in the United States. JAMA 1992; 267:937–940.

13   Martorell R, Habicht JP. Growth in early childhood in developing countries In: Falkner F, Tanner JM, eds. Human growth: a comprehensive treatise, 2nd edn, Volume 3. New York: Plenum Press, 1986; 241–62.

14   Huttly S, Victora C, Barros F, Teixeira A, Vaughan P. The timing of nutritional status determination: Implications for interventions and growth monitoring. Eur J Clin Nutr 1991; 45: 85–95.

15   Martorell R, Rivera J, Kaplowitz H. Consequences of stunting in early childhood for adult body size in rural Guatemala. Annales Nestlé 1990; 48:85–92.

16 Satyanarayana K, Radhaiah G, Murali Mohan KR, Thimmayamma BVS, Pralhad Rao N, Narasinga Rao BS. The adolescent growth spurt of height among rural Indian boys in relation to childhood nutritional background: An 18 year longitudinal study. Ann Hum Biol 1989; 16:289–300.

17 Billewicz WZ, McGregor IA. A birth-to-maturity longitudinal study of heights and weights in two West African (Gambian) villages, 1951–1975. Ann Hum Biol 1982; 9:309–20.

18 Hauspie MA, Nwaka CN, Omololu A. Effect of early malnutrition on subsequent growth in a group of Nigerian village children. Nutr Rep Int 1985; 35:885–91.

20 Dwyer JT, Andrew EM, Berkey C, Valadian I, Reed R. Growth in 'new' vegetarian preschool children using the Jenss-Bayley curve fitting technique. Am J Clin Nutr 1983; 37:815–827.

21 Sanders TAB, Purves R. An anthropometric and dietary assessment of the nutritional status of vegan preschool children. J Hum Nutr 1981; 35:349–357.

22 Dwyer JT, Dietz WH, Andrews EM, Suskind RM. Nutritional status of vegetarian children. Am J Clin Nutr 1982; 35:204–216.

23 Shull MW, Reed RB, Valadian I, Palombo R, Thorne H, Dwyer JT. Velocities of growth in vegetarian preschool children. Pediatrics 1977; 60: 410–417.

24 Trahms CM, Feeney MC. Evaluation of diet and growth of vegan, vegetarian, and nonvegetarian preschool children. Fed Proc 1977; 33:67S.

25 Kaplan RM, Toshima MT. Does a reduced fat diet cause retardation in child growth? Prev Med 1992; 21:33–52,

26 Jacobs C, Dwyer JT. Vegetarian children: appropriate and inappropriate diets. Am J Clin Nutr 1988; 48:S811–S818.

27 de Onis M et al. The worldwide magnitude of protein-energy malnutrition: an overview from the WHO global database on child growth. Bull WHO 1993; 71:703–712.

The nutritional status in pre-school children in poor rural areas of China

Chang Ying, Zhai Fengying , Li Wenjun, Ge Keyou, Jin Daxun and Mercedes de Onis

中國貧窮農村地區學齡前期兒童的營養狀況

摘要

該文介紹中國第一個大規模的、長期的營養研究的發現。該研究以主要營養向題和改善兒童的生長發育為目標，從 1986－1989 年研究了 18 個比較貧窮的農村地區將近一萬名學齡前期兒童的營養狀況。從這些兒童中取樣進行了身體測量、膳食調查和生化檢驗。結果發現生長障礙和低體重兒童的比率遠遠高過全國平均值。基於當地情況提供 5 年改善後，生長障礙和低體重的發病率有不同程度的減少，同時貧血在所有年齡組均明顯下降。隨著營養驗測的進展，應較多致力於培訓保健人員，提倡增加綠葉蔬菜、家禽和小家畜的生產。該研究搜集的資料和獲得的經驗可作為原始記錄，因為這個研究現在已擴大到全國 100 個縣中進行。