

# The nutrient intakes of Chinese children and adolescents and their impact on growth and development

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Considerable improvement has taken place in the growth and development of children and adolescents in China since 1949, and even since 1931, with the notable exception of war-time. There are interesting comparisons with Japan, with developing and developed nations, which provide insights into preferred eating patterns for children. These are borne out by intra-China analyses of rural and urban populations (urban generally fairing better), of majority Han and minority groups, of socio-economically advantaged and disadvantaged, and of regional populations. Energy intake and food nutrient density need, as expected, to be adequate. But particular problems remain, especially with iron, and Vitamin B-2, and probably with calcium, Vitamins A, B-1 and C intakes, although more often for marginal than frank deficiency. A "two-peak phenomenon" is also emerging in China, where about 80% of children aged 0-4 in urban areas, and 20-45% in rural areas, are only-children; this is that overfatness may co-exist with undernutrition. Primary health care in China is increasingly challenged by these dilemmas.

## Introduction

Children and adolescents are a population subset experiencing physical, mental and psychosocial development. Nutrition is a most important basis for growth and development. Enough energy, protein, vitamins, minerals and trace elements are needed by children and adolescents for rapid growth and development and related metabolism. Nutrient deficiency, an imbalance in nutrient intake, and poor food choice can lead not only to slower growth and development, but also to acute and chronic malnutrition and various kinds of nutrient deficiency.

China is a developing country. As the living standard of the people rises, the nutrient intake of children and adolescents is better than ever, and thus greatly promotes growth and development. This has been verified by the statistical data from three large-scale survey studies on the physical fitness and health of Chinese students in 1979, 1984 and 1991<sup>1,2,3</sup>. China now has a population of more than 1.1 billion. Among them, about 400 million are children and adolescents aged 0 through 18 years old, which account for 35.7% of the whole population. There are 20 million new births every year. The number of only-children is also increasing. In urban areas, 79-80% of the children aged 0-4 years are only-children, while the figure ranges from 20% to 45% in rural areas<sup>4</sup>.

The present article begins with changes in secular growth of Chinese children and adolescents since 1949, which can be attributed largely to the improvement in nutrition of the Chinese people.

## Secular Growth Changes of Chinese Children and Adolescents

Since the 1950s, a secular trend in children's growth has been obvious in China<sup>5</sup>. This trend has three characteristics:

- (1) It exists in every age group
- (2) The onset of the growth spurt is occurring earlier
- (3) The acceleration of growth is continuous.

**Table 1.** Increments in height and weight per decade of Chinese boys and girls aged 7 through 17 (1950's-1985)<sup>5</sup>

	7-	11-	14-	17-
<b>Height (cm)</b>				
Boys	1.94	3.00	3.69	1.75
Girls	1.88	3.30	2.34	1.32
<b>Weight (kg)</b>				
Boys	0.74	1.61	2.70	1.46
Girls	0.57	1.64	1.63	0.29

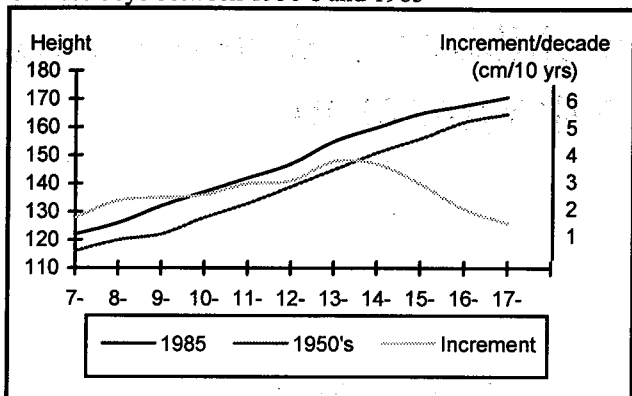
The height and weight of children and adolescents are the most basic and feasible indices for evaluation of nutritional status. Table 1 shows that the average increase in height per decade among Chinese urban boys aged 7, 11, 14 and 17 was 1.94cm, 3.00cm, 3.69cm and 1.75cm, respectively. Among the girls of the same ages it was 1.88cm, 3.30cm, 2.34cm and 1.32cm, respectively. Similarly, the average increase in weight per decade was 0.74kg, 1.61kg, 2.70kg and 1.46kg among boys, and 0.57kg, 1.64kg, 1.63kg and

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0.29kg among girls of the same ages, respectively.

**Figure 1.** The comparison of height and its change in Chinese boys between 1950's and 1985



In Figure 1, the upper line is boys' mean heights at different ages in 1985, and the lower line are those in 1955. The third line displays ten year increments. The largest increments can be found in those aged 12 through 14, when the Chinese boys were usually in their adolescent growth spurt.

Because of these changes toward larger size, boys aged 14 and girls aged 13 today, for example, would be as tall as the boys aged 15.5 and the girls aged 15 would have been forty years ago, respectively.

During the last forty years, Chinese boys and girls have undergone advancement in adolescence, indicated by the earlier onset of adolescent growth spurt, both for height and weight. Take height as an example, the age of the spurt onset was 12.9 years among boys and 11.7 years among girls in 1950s, but it advanced to 12.1 years and 11.2 years respectively in 1991. Looking at weight, the age of the spurt onset was 13.8 years among boys and 12.9 years among girls in 1950s, but advanced to 12.4 years and 11.8 years respectively in 1991<sup>3,6</sup>.

Ohsawa<sup>7</sup> uses boys from Shanghai as an example. An evident "track phenomenon" could be found during the 54 years from 1931 to 1985 when the secular trend was shifting positively. There was a negative shift, both in height and weight in 1944, due to the difficult life of the Chinese people in World War II. However, the growth trend seemed to get back on "track" after that, and an acceleration of height occurred, especially among 14 year old boys. The trend for weight was not as obvious.

The secular growth changes of four Chinese Minorities, the Mongolian, Uyгур, Tibetan and Chinese Korean Nationalities, had their own growth patterns. However, the changes toward larger size and earlier maturation are quite similar to those of the Han boys and girls<sup>8</sup>.

The causes of the Chinese children's secular growth changes are multiple. Control of infectious diseases, compulsory education, more available health and medical care, as well as social changes are possible contributing factors. However, the most important factor in these growth changes has been improved nutrition, especially increased energy-protein intake. Table 2 shows the changes in protein, sugar and fat intake in China during the last 40 years.

**Table 2.** The changes of intake of various kinds of food in China during 1950-1990 (on average) (kg/yr)<sup>9</sup>

Years	Cereal Food	Veg Oil	Meats	Eggs	Aquatic products	Sugar
1950-	195.7	2.10	7.27	1.02	2.67	0.91
1955-	203.1	2.42	6.69	1.26	4.34	1.51
1960-	164.6	1.09	3.39	0.77	2.96	1.60
1965-	182.8	1.72	7.67	1.42	3.33	1.68
1970-	187.2	1.61	7.16	1.32	2.94	2.06
1975-	190.5	1.73	8.70	1.63	3.26	2.26
1980-	213.8	2.30	12.79	2.27	3.41	3.84
1985-	251.7	5.08	16.71	4.93	4.84	5.57
1990-	238.8	5.67	20.10	6.27	6.79	4.98

Table 2 shows the change in eating patterns in China between 1950-1990. The consumption of vegetable oil, meats and aquatic products per capita per annum in 1990 were 1.70, 1.76 and 1.54 times those in 1950, respectively. The consumption of cereal foods only increased by 22% during this period. The consumption of eggs per capita per annum in 1990 were five times that of 40 years ago. This suggests that growth and development of Chinese adolescents, especially in height, is significantly related to the increase of animal protein intake<sup>9</sup>.

**Table 3.** The changes of food constitution of Chinese urban and rural inhabitants in 1978, 1985 and 1993 (kg/yr)<sup>9</sup>

Kind of food	1978		1985		1993	
	urban	rural	urban	rural	urban	rural
Cereal	158.1	248.0	133.9	257.0	127.9	255.6
Vegetable	142.6	142.0	144.3	131.0	135.2	127.0
Animal protein	24.7	7.7	35.9	15.7	42.9	18.4
Sugar	2.39	0.73	2.54	1.40	1.80	1.51

Table 3 describes the changes in four kinds of food constituents for Chinese urban and rural inhabitants from 1978 to 1985 and 1993. For urban people, the most significant changes were increased consumption of animal protein and decreased consumption of cereal foods. For rural, consumption of animal protein per capita per annum already increased from 7.7kg in 1978 to 18.4kg in 1993. Compared with urban, however, their major protein source was still cereal foods.

Now, the question is: is the nutrition of all Chinese children and adolescents sufficient? The answer is that it is still not ideal. Generally, the intake of energy and protein remain insufficient. After other nutritional problems of Chinese children and adolescents in cities, such as being overweight or obese must receive more attention. This is being referred to as the "two-peak phenomenon" in nutritional status of Chinese children and adolescents.

### The "Two-Peak Phenomenon" of Nutrition in Chinese Children and Adolescents

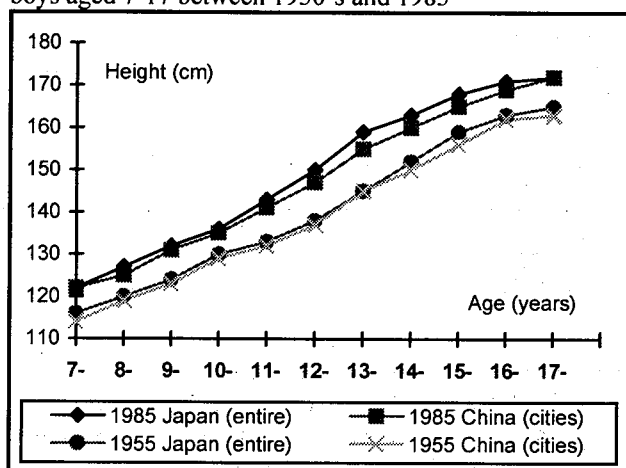
First, let us make some comparisons about food constituents, such as protein, fat and carbohydrate, between China and those in other countries. The protein and fat contents of the Chinese diet are much lower than those in developed countries, such as USA, United Kingdom, Germany, Australia, but are significantly higher than those in India, Indonesia, and Nigeria. However, just like the peoples living in other developing countries, most of the

Chinese people's energy and protein intakes still come from cereals, not animal derived foods.

**Table 4.** Comparison of energy, protein and fat in food eaten by Chinese and other populations<sup>9</sup>

Country	Food energy kcal/ day		Protein content g/ day		Fat content g/ day	
	Plant	Animal	Plant	Animal	Plant	Animal
USA	2388	1264	35.1	69.3	69.4	97.9
West Germany	2161	1315	33.9	58.9	44.3	110.7
UK	2012	1118	30.5	61.1	49.5	90.9
Australia	2225	1118	35.1	61.3	54.1	83.1
India	2036	125	46.1	6.3	27.2	8.5
Indonesia	2450	54	46.0	5.5	36.5	3.1
Nigeria	1987	73	38.0	7.0	40.2	4.2
Japan	2263	541	41.9	43.7	45.8	35.5
Chinese urban	1937	434	39.6	26.3	42.1	29.0
Chinese rural	2245	209	58.0	9.7	50.6	10.7

**Figure 2.** Comparison in height of Chinese and Japanese boys aged 7-17 between 1950's and 1985<sup>6</sup>



Let us take two examples. Figure 2 compares the difference in height between urban Chinese boys and Japanese boys aged 7 to 17 in 1955 and 1985. No significant differences are found between the two countries. This suggests that Chinese and Japanese children and adolescents had similar secular growth changes during this period.

**Table 5.** The worldwide incidence of LBW infants (%)<sup>10</sup>

Area	Incidence
Asia	20
Africa	15
Pacific	12
Latin America	11
China	9
Russia	8
Europe	8
North America	7

In Table 5, it can be seen that, although China is a developing country, the incidence of LBW (low-birth-weight) infants is only about 9%. It is quite different from other developing countries, because maternal malnutrition during the fetal period is not a big problem in China<sup>10</sup>.

**Table 6.** Comparison of Kaup index between Chinese and Japanese infants and preschoolers at different ages<sup>6,11</sup>

Age	Boys		Girls	
	Chinese	Japanese	Chinese	Japanese
0-3 days	12.7	13.0	12.7	12.9
5-6 months	17.1	18.1	17.3	17.8
8-10 months	17.7	17.5	17.2	17.5
15-18 months	16.5	16.5	16.3	16.3
21-24 months	16.0	16.3	16.0	16.1
2.0-2.5 years	15.8	16.2	15.9	15.9
3.0-3.5 years	15.4	15.9	15.7	15.7
4.0-4.5 years	15.0	15.7	15.2	15.5
5.0-5.5 years	14.7	15.4	14.8	15.3
6.0-7.0 years	14.6	15.3	14.7	15.2

Table 6 shows the Kaup Index of Chinese infants aged 5-6 months are significantly lower than that of the Japanese infants of the same age<sup>6,11</sup>. It suggests that among Chinese infants, the major problems are a lack in food supply and its insufficiency of energy and protein, although other nutrients could be involved. From 3-4 years of age, the Chinese infants' Kaup index lagged behind that of the Japanese infants again. This phenomenon extended to the preschool period. It suggests children's energy supply and food nutrient density during the early years are important issues.

**Table 7.** Prevalence of malnutrition in Chinese children under 5 years in 1985 (According to WHO norms)<sup>12</sup>

	Urban (%)	Rural (%)
Lower than WHO weight-for-age	5-10	20-25
Lower than WHO height-for-age	3.3	8.1
Lower than WHO weight-for-height	1.9	3.5

According to the WHO weight-for-age, height-for-age and weight-for-height norms, the most severe problem of Chinese preschool children is the insufficiency of body weight. The prevalence of underweight children is as high as 20-25% in rural areas. The adequacy of height, or stuntedness, is also significant among rural children (Table 8).

**Table 8.** Comparison of body size between Chinese urban and rural children aged 6 years old in 1985<sup>12</sup>

Geographic area in China	Weight (kg)		Height (cm)	
	urban	rural	urban	rural
Northeast	19.9	18.8	116.0	112.0
Northwest	18.4	17.8	114.4	111.2
Central	20.3	18.3	117.1	111.6
Southeast	18.8	17.2	114.3	108.1
Southwest	18.2	16.7	113.7	107.5

Comparisons of growth status among preschool children show that those living in Beijing and Tianjin have the best status and those living in Southwest China have the poorest status. Significant urban-rural differences can be seen in each province. Take the 6-year-old children living in Southwest China as an example, the urban-rural difference is 6.2cm for height and 1.5kg for weight<sup>12</sup>.

**Table 9.** The prevalence of malnutrition of preschool children in Jiangxi and Guizhou Provinces<sup>12</sup>

Surveillance post	Height-for-age (%)	Weight-for-age (%)	Weight-for-height (%)
Jiangxi #1	38.8	23.9	3.6
#2	36.5	23.0	3.8
#3	49.5	35.5	3.9
#4	62.8	34.3	3.1
Guizhou #1	59.2	30.5	3.0
#2	74.3	49.3	3.5
#3	64.0	42.7	3.6

Table 9 shows that in some Chinese rural areas, the prevalence of underweight and underheight, according to the WHO norms, is quite high. These data come from several Chinese rural areas where the socioeconomic levels are the lowest. From now on, the improvement of energy-protein intake of children in these areas will be one of the main intervention strategies of primary health care.

**Table 10.** Prevalence of Nutritional problems among Chinese rural youths (%)<sup>3</sup>

Age (yr)	Malnutrition		Underweight		Overweight		Obese	
	boys	girls	boys	girls	boys	girls	boys	girls
7-	1.01	1.73	22.57	31.21	1.32	1.49	0.55	0.59
9-	1.11	2.38	24.39	32.44	2.56	1.83	0.77	0.59
12-	2.51	3.18	27.55	28.11	3.09	4.83	1.24	1.95
14	2.02	8.96	24.12	32.55	3.56	4.31	1.37	0.96
17-	1.86	4.87	25.19	30.80	3.41	2.98	0.51	0.48
total	1.66	4.42	24.38	31.10	2.76	3.23	0.79	0.76

The same conclusion can be drawn from Table 10. The prevalence of marginal malnutrition is still quite high in Chinese rural areas, especially among the girls. Being overweight or obese are not common at present.

**Table 11.** Prevalence of nutritional problems among Chinese urban youths (%)<sup>3</sup>

Age (yr)	Malnutrition		Underweight		Overweight		Obese	
	boys	girls	boys	girls	boys	girls	boys	girls
7-	1.19	2.63	25.09	35.11	4.50	3.28	2.93	1.50
9-	2.16	4.95	28.15	36.43	6.02	3.52	4.87	2.71
12-	4.66	7.58	31.69	31.20	5.34	6.30	4.94	3.79
14-	4.92	12.90	31.34	34.60	5.29	3.68	3.73	2.59
17-	5.72	11.51	31.51	38.18	5.11	3.16	2.62	1.10
total	3.71	8.14	29.69	38.10	4.96	2.61	3.79	1.76

However, a paradoxical phenomenon among urban adolescents can be found in Table 11. The prevalence of marginal malnutrition is quite high, especially among girls who are in their adolescent growth spurt. On the other hand, the prevalence of overweightness and obesity, especially among boys, is rather high. This is the "two peak phenomenon".

According to another investigation, the prevalence of obesity in Chinese cities tripled during the 1985-1992 period. Thus prevention of child and adolescent obesity due to over nutrition will be another intervention confronting primary health care.

#### Intake of Other Nutrients of Chinese Children and Adolescents

This section will focus on the problems of Chinese children's intake of nutrients other than energy-protein.

**Table 12.** The nutrient intakes of Chinese pre-school children and the comparisons with China's RDA and WHO RDA.<sup>12</sup>

Nutrients	Average intake	% of China's RDA	% of WHO RDA
Energy	1292 kcal	90	80
Protein	15 g	78	195
Ca	318 mg	42	65
Fe	15 mg	162	150
Vit A	120 µg	19.2	17.7
Vit B-1	1.1 mg	122	180
Vit B-2	0.4 mg	49	45
Niacin	8 mg	92	75
Vit. C	34 mg	85	170

Table 12 suggests that Chinese children have insufficient intakes of calcium and Vitamin B-2. As far as calcium intake is concerned, there is a shortage of milk for children to drink, especially in large rural areas. But there may be some aspects of Chinese food content which compensate for apparently low calcium intakes. Comparisons with both Chinese and WHO RDAs show that Fe intake is sufficient. But the fact that most of these nutrients come from plant food and are difficult to absorb must be taken into consideration. Nutrients that need to be bolstered in Chinese children's food are calcium, iron, Vitamin A and Vitamin B-2.

**Table 13.** Prevalence of 4 kinds of Vitamin deficiency among Chinese pre-school children (%)<sup>13</sup>

	Vit A	Vit B-1	Vit B-2	Vit C
Deficiency	2.9	0.4	5.8	1
Marginal deficiency	40.3	20-32	29-52	9-28

From Table 13, it can be concluded that serious deficiencies of Vitamin A, B-1 and B-2 are rare among Chinese children, and most occur in the low socioeconomic areas in Northwest China. The prevalence of Vitamin C deficiency is not high, but has appears seasonally in spring and winter. However, there is a high prevalence and high popularity of marginal nutrient deficiencies.

Anemia caused by iron-deficiency and rickets caused by Vitamin D or calcium deficiency have major impacts on the growth and development of Chinese children and adolescents.

**Table 14.** Prevalence of rickets among Chinese pre-school children (%)<sup>14</sup>

	Urban	Rural
North China	13.2 (9-19)	40.6 (29-74)
South China	5.3 (4-9)	25.1 (17-41)

Table 14 shows that the prevalence of rickets among Chinese infants is still very high. Its overall characteristics are:

- (1) the prevalence is higher in rural areas than urban areas;
- (2) the prevalence is significantly higher in the North than in the South;
- (3) the peak of prevalence is in spring following the long winter with inadequate sunshine;
- (4) about 62% of suffering infants and children are younger than one year old. However, most of these infants are mild

cases. Their occurrence can be alleviated by attention during pregnancy, an increase in outdoor activities, and increases in calcium, phosphorus and Vitamin D intakes<sup>14,15,16</sup>.

**Table 15.** Prevalence of iron deficiency anemia among Chinese pre-school children (%)<sup>17</sup>

Geographic Area	Urban	Rural
South China	55.7	63.5
Southeast China	64.1	82.7
North China	40.5	45.9

Table 15 shows the prevalence of iron-deficiency anemia of Chinese infants and young children aged 0 through 4. According to the 110g Hb/ L cut-off for anemia, the prevalence is high, even as high as 82.7% among some rural areas in several provinces around the Yangtze Valley<sup>18</sup>.

**Table 16.** Prevalence of iron deficiency anemia among Chinese youth (%)<sup>3</sup>

Age (yr.)	Urban		Rural		Total
	boy	girl	boy	girl	
7-	14.46	18.32	21.81	22.48	19.24
9-	13.04	15.38	19.11	21.11	17.14
12-	28.00	23.37	31.30	26.67	27.35
14-	13.94	18.66	20.04	21.61	18.55
17	15.91	23.40	14.65	23.66	19.39

In Table 16, it can be seen that the incidence of iron-deficiency anemia is high among Chinese children and adolescents aged 7 through 17, especially if rural and puberal. The prevention of iron-deficiency anemia is not only part of the "four major disease-control in early-childhood (rickets, iron-deficiency, pneumonia, diarrhea)", but also one a major goal of adolescent health care.

Child and adolescent iodine-deficiency and endemic diseases caused by excessive fluorine intake, although they belong to the field of nutrition, will not be discussed here.

Among the factors that influence growth and development of children and adolescents, nutrition and physical activity are the most important. To promote growth and development of children and adolescents and prevent adulthood diseases during childhood, are major tasks in primary health care for children. Effective health education about nutrition should be provided. The target population should also include parents, administrative officers and personnel who are in charge of food arrangement at schools. Extensive nutrition education will promote child and adolescent health.

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The nutrient intakes of Chinese children and adolescents and their impact on growth and development

## 中国儿童、青少年营养素摄入状况及其对生长发育的影响

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#### 摘要:

近40年来,中国儿童、青少年的生长发育趋势的特点为:各年龄组体格发育都明显增长;青春期生长发育突增不断提前;且目前仍表现出加速增长。例如,今天14岁的男孩和40年前的15岁半男孩一样高,今天13岁女孩的身高相当于40年前的15岁女孩。这种变化趋势的重要原因之一是营养摄入有明显改善,特别是能量和蛋白质的摄入有大幅度的增加。然而,应该指出中国儿童、青少年的营养状况存在着明显的“双峰现象”,即某些贫困农村中体重不足(能量—蛋白质不足)以及贫血和佝偻病比较普遍,而在城市中又同时出现肥胖问题(城市儿童肥胖率在1985-1992年间增加了两倍)。在微量营养素的膳食摄入方面,主要问题是钙和核黄素的不足和维生素A偏低(亚临床型缺乏)。

## References

- 1 State Physical Culture Commission, Ministry of State Education, Ministry of Public Health, Research Group for the Physical Fitness of Chinese Children and Adolescents, et al. Study of the Physical Constitution Function and Motor Ability of Children and Adolescents in China. Beijing: Science and Technology Literature Publishing House, 1982.
- 2 Research Group for the Constitution and Health of Chinese Students. Research on the Constitution and Health of Chinese Students in 1985. Beijing: People's Education Press, 1993.
- 3 Research Group for the Physical Fitness and Health of Chinese School Students. Report on the Physical Fitness and Health Surveillance of Chinese School Students in 1991. Beijing: Science and Technology Publishing House, 1993.
- 4 Qin H. The developing Child Food Industry in China. Symposium Proceedings of 6th International Symposium on Maternal and Infant Nutrition. Guangzhou: Heinz Institute of Nutritional Sciences, 1990: C,7.
- 5 Lin WS, et al. Secular Change in the Growth and Development of Han children in China. *Annals of Human Biology* 1992, 19(3): 260-263.
- 6 Research Group for the Physical Growth and Development of Children and Adolescents in Nine Municipalities in China. Researches on the 1985 Survey of Physical Growth and Development of Chinese Children and Adolescents in Nine Municipalities. Beijing: Institute of Pediatric Studies, 1987.
- 7 Seiji Ohsawa, Ji C. Secular Growth Changes of Chinese Boys the Morphological Changes of the Urban ones. *Jpn J School Health* 1993; 35 (7) 342-351.
- 8 Ji C. Present and Future of Adolescent Growth and Development in China. *Adolescent and Health* 1994; 1:4-8.
- 9 Chinese State Statistics Bureau, 1991 China Statistical Yearbook, Beijing: Chinese Statistical Publishing House, 1993
- 10 United Nations Children's Fund Children and Women of China UNICEF Situation Beijing CDCC, 1989
- 11 Research Group for the Physical Growth and Development of Chinese Children Under Seven in the Provinces in Rural Areas Researches on the 1985 survey of physical growth and development of Chinese Children Under Seven in Ten Provinces in Rural Areas Beijing Institute of Pediatric Studies, 1987
- 12 United Nations Children's Fund Children and Women of China UNICEF Situation Analysis Beijing CDCC, 1989: 27-32
- 13 *Acta Nutrimenta Sinica*, 1988-1992
- 14 United Nations Children's Fund Children and Women of China UNICEF Situation Analysis Beijing: CDCC, 1990-1991.
- 15 Qin H Prevention of Vitamin D-Deficiency Rickets and Calcium Deficiency Among Infants. Symposium Proceedings Of 6th International Symposium on Maternal and Infant Nutrition Guangzhou: Heinz Institute of Nutritional Sciences, 1991: C 49-C 54
- 16 Chen X Rickets and Its Prevention in Beijing, China Children's Nutrition (Symposium Proceedings of Sino-Sweden Symposium on Children Nutrition and Food) Beijing CDCC, 1989:11-12
- 17 Symposium Proceedings of 3rd International Symposium on Maternal and Infant Nutrition. Guangzhou: Heinz Institute of Nutritional Sciences, 1988. (Data from the survey on iron deficiency anemia in 16 provinces and cities.)
- 18 Liu D. Survey on Iron-Deficiency Anemia in 16 Provinces and Cities Symposium Proceedings of 3rd International Symposium on Maternal and Infant Nutrition Guangzhou Heinz Institute of Nutritional Sciences, 1988