Original Article

Physical Growth of Children in Urban, Suburban and Rural Mainland China: A Study of 20 Years' Change*

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Abstract

Objective To describe secular trends on physical growth of children in China during the year of 1985-2005 and to analyze the urban-suburban-rural difference and its change.

Methods The measurements of height, weight and chest circumference obtained from two serial national cross-sectional surveys for children aged 0 to 7 years in China were used to analyze the secular trends, and the growth differences among urban, suburban and rural children were compared.

Results The average weight and height for both boys and girls from urban, suburban and rural areas have significantly increased in most age groups during the past 20 years; The average chest circumference increased slightly, ranging from 0.0 to 2.0 cm. From 1985 to 2005, the urban-suburban difference in height had become smaller, and that in weight showed similar trend for children under 3 years old but became larger after 3 years old; the suburban-rural difference both in height and weight became larger after 6 months old. The increment per decade in height was the greatest in the suburban group while the greatest increment in weight was the urban group.

Conclusion Positive secular trends were observed among urban, suburban and rural areas in Chinese children under 7 years old during the 1980s and the 2000s, reflecting a rapid socio-economic development in China.

Key words: Growth; Secular trends; Height; Weight; Chest circumference

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INTRODUCTION

Data on physical growth of children can not only provide important information on the health and nutritional status of an individual or a population, but also reflect the comprehensive developmental conditions of social politics, economy and culture of a nation[1]. Therefore, many countries and governmental and international agencies pay great attention to regular collection and analysis of anthropometric data[2-7]. By coupling with relevant statistical analysis on the growth level and its secular change, they can measure the general well-being of population, formulate health related policies, develop interventions and monitor their effectiveness.

In China, a large national cross-sectional growth survey was conducted in Mainland in 1975[8-9]. It was a National Growth Survey of Children under 7 years of age in Nine Cities of China (NGSCNCC) sponsored and supported by Chinese Ministry of Health, organized and implemented by the Capital Institute of Pediatrics and the Coordinating Study Group of Nine Cities on the Physical Growth and Development of Children. In this survey, children with half from urban and half from suburban rural areas were

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measured for weight, height, sitting height, chest circumference, and head circumference. To compare the secular changes, the second NGSCNCC was conducted in 1985[10] in the same places and by the same methods as the first in 1975. Considering that the results of the NGSCNCC only came from urban and suburban rural children and the latter could not completely represent the rural children who lived far away from cities, the Ministry of Health decided therefore to carry out another Nationwide Growth Survey for Rural Children under 7 years old in Ten, Provinces in China (NGSRCTPC)[11] using the same methods with the NGSCNCC in the same year. This study was organized and implemented by the Capital Institute of Pediatrics and the Coordinating Study Group of Ten Provinces on the Physical Growth and Development of Children. The two growth surveys could provide overall status of growth, nutrition and health for Chinese children aged from birth to 7 years. The fourth NGSCNCC survey was performed in 2005[12] and the second NGSRCTPC in 2006. From the 1980s to the 2000s, a high-speed economic growth had been presented in most parts of Mainland China because of adopting the policy of reform and opening up to the outside world since 1978, and the positive secular trends in physical growth of Chinese school children and adolescents were also more obvious[13-15]. The aim of the present study is to examine differences in the secular trends in height, weight, and chest circumference of children below 7 years old from three different socio-economic classes in Mainland China in the past 20 years.

SUBJECTS AND METHODS

Data came from two national cross-sectional growth surveys, which were the National Growth Survey of Children under 7 years of age in nine cities in China (NGSCNCC) in 1985 and 2005 and the National Growth Survey for Rural Children under 7 years of age in ten provinces in China (NGSRCTPC) in 1985 and 2006.

Subjects

NGSCNCC: The survey locations were Beijing, Harbin and Xi'an in the northern part; Shanghai, Nanjing and Wuhan in the central part; Guangzhou, Fuzhou and Kunming in the southern part of China. The nine cities are main large cities in Mainland China. Of them, Beijing and Shanghai are municipalities, and the other seven are provincial capitals. The urban children from nine cities represented the well-being population and the suburban rural children represented the relative better living conditions in rural population. The sampling method was random cluster sampling according to the requirements of age interval, with children under 3 years of age in communities as a minimum cluster unit and children over 3 years of age (including 3 years of age) in kindergartens as a unit. This series of surveys was organized and implemented by the Capital Institute of Pediatrics and the Coordinating Study Group of Nine Cities on the Physical Growth and Development of Children. 152 874 subjects (with 79 194 from urban and 73 680 from suburban rural areas) were included in the survey in 1985. And in 2005, the subjects consisted of 138 775 children (with 69 760 from urban and 69 015 from suburban rural areas).

NGSRCTPC: This series of surveys was conducted in ten provinces (including Jilin, Shanxi, Gansu, and Xinjiang in the northern part, Jiangsu, Sichuan, Jiangxi, Hunan, Guangxi and Guizhou in the southern part of China). All subjects were from countryside in counties and their parents were farmers. The sample size was 87 645 in 1985 and 95 925 in 2006. The overall study methods, sampling method, inclusion and exclusion criteria for subjects and measurement techniques were the same as those used in the NGSCNCC.

Study Design

All subjects were healthy children with boys and girls of equal number, randomly selected from the registry areas. Exclusion criteria were temporary residents, history of premature birth, birth weight less than 2 500 g, twins, acute illness within a month, chronic illness, obviously malnourished, physical handicap. Total subjects were divided into 22 age groups: newborn to 3 days, monthly for 1-6 months, bi-monthly for 6-12 months, tri-monthly for 12-24 months, half-yearly for 2-6 years, and yearly for 6-7 years. The "1 month" group included data of those who were aged from 1 month to 1 day less than 2 months. Likewise, the 2 year group was a group with the age ranging from 2 years to 1 day less than 2 years and 6 months. The sample size was 150-200 for each sex-age group in each area (urban/rural) of each city/province.

Measurements

Height was measured supine with a horizontal metal infantometer for children under 3 years of age, while metal column height and sitting height

measuring was applied to children over 3 years of age. All height data were recorded to the nearest 0.1 cm. Weight was obtained with children wearing the lightest vest and shorts by using beam scales, with one for newborn or infants of up to 10 kg accurate to 50 g and the other for children of up to 50kg to the accuracy of 100 g[8-9]. Chest circumference was measured with a soft ruler with 0.1 cm precision. All measurements were carried out by specially trained child health care workers or pediatricians/nurses following the standardized methods and quality control procedures. The same measuring instruments were equipped for each field sites. The survey started in May and finished in October of the same year. All the measurements were carried out at least one hour after a meal, between approximately 8 a.m. and 4 p.m.

Description and Analysis

There are some differences between urban, suburban and rural areas because of their distinct actual socio-economic positions in China. Stratified by sex and area of residence, it includes six populations, urban boys, urban girls, suburban boys, suburban girls, rural boys and rural girls. T-test was used to examine the growth differences among different populations or periods. Absolute increments (including average increments per decade) and relative increment rates (%) in height, weight and chest circumference for each sex-age subgroup were calculated from 1985 to 2005/2006.

RESULTS

The Change of Physical Growth of Chinese Children under 7 Years of Age (1985-2005/2006)

The mean height, weight, and chest-circumference for children aged 0-7 years from urban, suburban and rural areas in 1985 and 2005/2006 were given in Tables 1 to 3 respectively. Absolute and relative (%) increments in mean height, weight and chest-circumference were also shown. The results indicated that the physical growth of Chinese children in most of the age groups for both boys and girls from urban, suburban and rural areas had been greatly improved during the past 20 years.

Weight

Table 1 showed that the mean weight of boys and girls in all age groups from urban, suburban and rural areas increased in different rates between 1985 and 2005. For example, the mean increments of weight in the birth to 3 days group were very similar, ranging from 0.10 kg to 0.12 kg. But in the 6 to 7 years of age group, the mean weight of urban boys and girls increased by 2.70 kg and 2.47 kg, with the average increasing rates being 13.6% and 12.9% respectively; the mean weight of suburban boys and girls increased by 2.45 kg and 2.19 kg, with the average increasing rates being 13.4% and 12.2% respectively; and the mean weight of rural boys and girls increased by 1.14 kg and 0.98 kg, with the average increasing rates being 6.4% and 6.7% respectively.

Height

Compared with the results in 1985, the mean heights in both boys and girls from urban, suburban and rural areas increased significantly except in the birth to 3 days group for rural children (-0.1 cm). Table 2 showed the mean height increments in the past 20 years. For example, the mean height increments were 1.8 cm, 2.6 cm, and 1.6 cm for urban, suburban and rural boys at ages of 12 to 15 months respectively and 1.7 cm, 2.4 cm, and 1.7 cm for girls from the corresponding areas and of the same age group, 3.8 cm, 5.6 cm, and 3.6 cm for boys from urban, suburban and rural areas at ages of 6 to 7 years respectively and 3.8 cm, 5.2 cm, and 3.4 cm for corresponding girls. It could be seen that the height increasing rates of suburban boys and girls were the highest and those of urban and rural peers were similar.

Chest Circumference

Unlike the weight and height, only slight increments on chest circumference could be seen among all age groups. At the birth to 3 days group, the average chest circumference increments of urban, suburban and rural children were 0.6 cm, 0.3 cm and 0.6 cm for boys and 0.4 cm, 0.1 cm and 0.5 cm for girls respectively. After 4 years of age, the chest circumference of urban boys increased by 1.1 cm to 2.0 cm, urban girls by 0.9 cm to 1.7 cm, suburban children by 0.3 cm to 0.8 cm, but those of rural boys and girls increased very slightly by 0.1 cm to 0.2 cm (Table 3).

Urban-suburban Difference in Growth (1985-2005/2006)

Urban boys and girls were heavier and taller than their suburban counterparts. The urban-suburban

difference in height had become smaller over time. For instance, the difference decreased from 4.4 cm in 1985 to 2.6 cm in 2005 for boys and from 3.8 cm to 2.4 cm for girls at ages of 6-7 years. The difference in weight also showed a decreasing tendency for boys under 3 years of age and for girls less than 4 years old, but the difference became larger again after 3-4 years of age (Tables 4-5).

Suburban-rural Difference in Growth (1985-2005/2006)

Suburban children were also heavier and taller than their rural peers. The suburban-rural difference in weight and height became larger and larger after 6 months of age, especially after 2 years old. For example, at ages of 6-7 years, the suburban-rural difference in height for boys and girls had increased from 1.9 cm, 2.2 cm in 1985 to 3.9 cm, 4.0 cm in 2005/2006 respectively; and those in weight for boys and girls had increased from 0.41 kg, 0.54 kg in 1985 to 1.72 kg, 1.75 kg in 2005/2006 respectively (Tables 4-5).

Increment per Decade

Between 1985 and 2005/2006, the average increments per decade in height were suburban > urban > rural boys and girls. However, the increment trends had some difference in weight: under 3 years for boys and 4 years for girls the orders of increments per decade were suburban > urban > rural children, while after that ages the orders changed to urban > suburban > rural children. The orders of increments per decade in chest circumference were suburban > urban > rural children under 3 years, but it changed to urban > suburban > rural children over 3 years (Table 6).

Table 1. Secular Change in Weight of Chinese Children in Urban, Suburban and Rural Areas, 1985- 2005/2006

Sex	Age Group	Urban				Suburban				Rural			
		1985	2005	It (kg)	Ir (%)	1985	2005	It (kg)	Ir (%)	1985	2006	It (kg)	Ir (%)
Boys	0-3 d	3.21	3.33*	0.12	3.7	3.22	3.32*	0.1	3.1	3.17	3.27*	0.10	3.2
	1 m	4.90	5.11*	0.21	4.3	4.95	5.12*	0.17	3.4	4.81	4.93*	0.12	2.5
	2 m	6.02	6.27*	0.25	4.2	5.96	6.29*	0.33	5.5	5.75	5.97*	0.22	3.8
	3 m	6.74	7.17*	0.43	6.4	6.60	7.08*	0.48	7.3	6.42	6.80*	0.38	5.9
	4 m	7.36	7.76*	0.40	5.4	7.19	7.63*	0.44	6.1	6.92	7.37*	0.45	6.5
	5 m	7.79	8.32*	0.53	6.8	7.53	8.15*	0.62	8.2	7.29	7.85*	0.56	7.7
	6 m	8.39	8.75*	0.36	4.3	8.05	8.57*	0.52	6.5	7.73	8.22*	0.49	6.3
	8 m	9.00	9.35*	0.35	3.9	8.58	9.18*	0.60	7.0	8.20	8.78*	0.58	7.1
	10 m	9.44	9.92*	0.48	5.1	8.94	9.65*	0.71	7.9	8.57	9.15*	0.58	6.8
	12 m	9.87	10.49*	0.62	6.3	9.34	10.11*	0.77	8.2	8.97	9.68*	0.71	7.9
	15 m	10.38	11.04*	0.66	6.4	9.81	10.59*	0.78	8.0	9.45	10.19*	0.74	7.8
	18 m	10.88	11.65*	0.77	7.1	10.29	11.21*	0.92	8.9	9.94	10.72*	0.78	7.8
	21 m	11.42	12.39*	0.97	8.5	10.79	11.82*	1.03	9.5	10.49	11.20*	0.71	6.8
	2.0 y	12.24	13.19*	0.95	7.8	11.61	12.65*	1.04	9.0	11.30	11.92*	0.62	5.5
	2.5 y	13.13	14.28*	1.15	8.8	12.50	13.81*	1.31	10.5	12.10	12.75*	0.65	5.4
	3.0 y	13.95	15.31*	1.36	9.7	13.42	14.65*	1.23	9.2	13.01	13.74*	0.73	5.6
	3.5 y	14.75	16.33*	1.58	10.7	14.13	15.51*	1.38	9.8	13.69	14.50*	0.81	5.9
	4.0 y	15.61	17.37*	1.76	11.3	14.94	16.49*	1.55	10.4	14.54	15.37*	0.83	5.7
	4.5 y	16.49	18.55*	2.06	12.5	15.69	17.46*	1.77	11.3	15.17	16.08*	0.91	6.0
	5.0 y	17.39	19.90*	2.51	14.4	16.46	18.46*	2.00	12.2	16.00	17.00*	1.00	6.3
	5.5 y	18.30	21.16*	2.86	15.6	17.22	19.58*	2.36	13.7	16.71	17.69*	0.98	5.9
	6~7 y	19.81	22.51*	2.70	13.6	18.34	20.79*	2.45	13.4	17.93	19.07*	1.14	6.4
	Average			1.05	8.0			1.03	8.6			0.64	6.0

(Contiued)

Sex	Age Group	Urban				Suburban				Rural			
		1985	2005	It (kg)	Ir (%)	1985	2005	It (kg)	Ir (%)	1985	2006	It (kg)	Ir (%)
	0-3 d	3.12	3.24*	0.12	3.8	3.11	3.19*	0.08	2.6	3.06	3.17*	0.11	3.6
	1 m	4.60	4.73*	0.13	2.8	4.67	4.79*	0.12	2.6	4.46	4.68*	0.22	4.9
	2 m	5.54	5.75*	0.21	3.8	5.48	5.75*	0.27	4.9	5.27	5.62*	0.35	6.6
	3 m	6.22	6.56*	0.34	5.5	6.07	6.51*	0.44	7.2	5.90	6.29*	0.39	6.6
	4 m	6.78	7.16*	0.38	5.6	6.59	7.08*	0.49	7.4	6.36	6.88*	0.52	8.2
	5 m	7.24	7.65*	0.41	5.7	7.04	7.54*	0.50	7.1	6.76	7.26*	0.50	7.4
	6 m	7.78	8.13*	0.35	4.5	7.48	7.98*	0.50	6.7	7.19	7.66*	0.47	6.5
	8 m	8.36	8.74*	0.38	4.5	7.89	8.54*	0.65	8.2	7.61	8.18*	0.57	7.5
	10 m	8.80	9.28*	0.48	5.5	8.26	9.00*	0.74	9.0	7.96	8.58*	0.62	7.8
	12 m	9.24	9.80*	0.56	6.1	8.71	9.44*	0.73	8.4	8.42	9.08*	0.66	7.8
	15 m	9.78	10.43*	0.65	6.6	9.22	9.97*	0.75	8.1	8.88	9.64*	0.76	8.6
Girls	18 m	10.33	11.01*	0.68	6.6	9.77	10.63*	0.86	8.8	9.36	10.18*	0.82	8.8
	21 m	10.87	11.77*	0.90	8.3	10.21	11.21*	1.00	9.8	9.86	10.69*	0.83	8.4
	2.0 y	11.66	12.60*	0.94	8.1	10.98	12.04*	1.06	9.7	10.62	11.34*	0.72	6.8
	2.5 y	12.55	13.73*	1.18	9.4	11.97	13.18*	1.21	10.1	11.51	12.19*	0.68	5.9
	3.0 y	13.44	14.80*	1.36	10.1	12.79	14.22*	1.43	11.2	12.43	13.12**	0.69	5.6
	3.5 y	14.26	15.84*	1.58	11.1	13.70	15.09*	1.39	10.1	13.16	13.90*	0.74	5.6
	4.0 y	15.21	16.84*	1.63	10.7	14.32	15.99*	1.67	11.7	13.96	14.81*	0.85	6.1
	4.5 y	16.12	18.01*	1.89	11.7	15.14	16.84*	1.70	11.2	14.58	15.56*	0.98	6.7
	5.0 y	16.79	18.93*	2.14	12.7	15.94	17.85*	1.91	12.0	15.45	16.44*	0.99	6.4
	5.5 y	17.72	20.27*	2.55	14.4	16.63	18.83*	2.20	13.2	16.09	17.21*	1.12	7.0
	6~7 y	19.08	21.55*	2.47	12.9	17.92	20.11*	2.19	12.2	17.38	18.36*	0.98	5.6
	Average			0.97	7.7			1.00	8.7			0.66	6.7

Note. It: total increments of weight from 1985 to 2005/2006 (kg); Ir: rate of It based on the 1985 measurements (%). *t*-test: * $P < 0.01$, ** $P < 0.001$.

Table 2. Secular Change in Height of Chinese Children in Urban, Suburban and Rural Areas, 1985- 2005/2006

Sex	Age Group	Urban				Suburban				Rural			
		1985	2005	It (cm)	Ir (%)	1985	2005	It (cm)	Ir (%)	1985	2006	It (cm)	Ir (%)
	0-3 d	50.2	50.4**	0.2	0.4	50.2	50.4**	0.2	0.4	50.1	50.0*	-0.1	-0.2
	1 m	56.5	56.8**	0.3	0.5	56.4	56.6**	0.2	0.4	55.5	55.8**	0.3	0.5
	2 m	60.1	60.5**	0.4	0.7	59.7	60.5**	0.8	1.3	58.7	59.3**	0.6	1.0
	3 m	62.4	63.3**	0.9	1.4	61.7	63.0**	1.3	2.1	60.9	62.0**	1.1	1.8
	4 m	64.5	65.7**	1.2	1.9	63.7	65.0**	1.3	2.0	62.6	64.1**	1.5	2.4
	5 m	66.3	67.8**	1.5	2.3	65.3	67.0**	1.7	2.6	64.2	66.0**	1.8	2.8
	6 m	68.6	69.8**	1.2	1.7	67.5	69.2**	1.7	2.5	66.5	67.7**	1.2	1.8
	8 m	71.3	72.6**	1.3	1.8	70.0	72.1**	2.1	3.0	69.0	70.4**	1.4	2.0
	10 m	73.8	75.5**	1.7	2.3	72.3	74.7**	2.4	3.3	71.4	72.7**	1.3	1.8
	12 m	76.5	78.3**	1.8	2.4	74.9	77.5**	2.6	3.5	73.8	75.4**	1.6	2.2
	15 m	79.2	81.4**	2.2	2.8	77.4	80.2**	2.8	3.6	76.1	78.2**	2.1	2.8
Boys	18 m	81.6	84.0**	2.4	2.9	79.6	82.8**	3.2	4.0	78.2	80.7**	2.5	3.2

(Contiued)

Sex	Age Group	Urban				Suburban				Rural			
		1985	2005	It (cm)	Ir (%)	1985	2005	It (cm)	Ir (%)	1985	2006	It (cm)	Ir (%)
	21 m	84.4	87.3**	2.9	3.4	81.9	85.8**	3.9	4.8	80.6	82.9**	2.3	2.9
	2.0 y	87.9	91.2**	3.3	3.8	85.4	89.5**	4.1	4.8	83.8	86.3**	2.5	3.0
	2.5 y	91.7	95.4**	3.7	4.0	88.9	93.7**	4.8	5.4	87.0	90.0**	3.0	3.4
	3.0 y	95.1	98.9**	3.8	4.0	92.5	97.2**	4.7	5.1	90.5	93.9**	3.4	3.8
	3.5 y	98.5	102.4**	3.9	4.0	95.4	100.5**	5.1	5.3	93.5	97.1**	3.6	3.9
	4.0 y	102.1	106.0**	3.9	3.8	99.0	103.9**	4.9	4.9	97.2	100.6**	3.4	3.5
	4.5 y	105.3	109.5**	4.2	4.0	102.0	107.4**	5.4	5.3	99.8	103.5**	3.7	3.7
	5.0 y	108.6	113.1**	4.5	4.1	105.3	110.7**	5.4	5.1	103.1	106.8**	3.7	3.6
	5.5 y	111.6	116.4**	4.8	4.3	108.1	113.6**	5.5	5.1	105.8	109.4**	3.6	3.4
	6~7 y	116.2	120.0**	3.8	3.3	111.8	117.4**	5.6	5.0	109.9	113.5**	3.6	3.3
	Average			2.5	2.7			3.2	3.6			2.2	2.6
	0-3 d	49.6	49.7*	0.1	0.2	49.6	49.8**	0.2	0.4	49.5	49.4*	-0.1	-0.2
	1 m	55.6	55.6	0.0	0.0	55.5	55.6*	0.1	0.2	54.5	54.9**	0.4	0.7
	2 m	58.8	59.1**	0.3	0.5	58.4	59.0**	0.6	1.0	57.3	58.3**	1.0	1.7
	3 m	61.1	62.0**	0.9	1.5	60.4	61.7**	1.3	2.2	59.5	60.7**	1.2	2.0
	4 m	63.1	64.2**	1.1	1.7	62.2	63.6**	1.4	2.3	61.3	62.8**	1.5	2.4
	5 m	64.8	66.2**	1.4	2.2	64.0	65.5**	1.5	2.3	62.9	64.5**	1.6	2.5
	6 m	67.0	68.1**	1.1	1.6	66.0	67.6**	1.6	2.4	65.0	66.4**	1.4	2.2
	8 m	69.7	71.1**	1.4	2.0	68.4	70.5**	2.1	3.1	67.4	69.1**	1.7	2.5
	10 m	72.3	73.8**	1.5	2.1	70.8	73.2**	2.4	3.4	69.9	71.3**	1.4	2.0
	12 m	75.1	76.8**	1.7	2.3	73.4	75.8**	2.4	3.3	72.4	74.1**	1.7	2.3
	15 m	77.9	80.2**	2.3	3.0	76.0	78.9**	2.9	3.8	74.6	76.9**	2.3	3.1
Girls	18 m	80.4	82.9**	2.5	3.1	78.5	81.7**	3.2	4.1	76.8	79.6**	2.8	3.6
	21 m	83.1	86.0**	2.9	3.5	80.6	84.4**	3.8	4.7	79.1	81.9**	2.8	3.5
	2.0 y	86.6	89.9**	3.3	3.8	83.8	88.2**	4.4	5.3	82.1	85.0**	2.9	3.5
	2.5 y	90.3	94.3**	4.0	4.4	87.8	92.4**	4.6	5.2	85.6	88.9**	3.3	3.9
	3.0 y	94.2	97.6**	3.4	3.6	91.0	96.2**	5.2	5.7	89.4	92.5**	3.1	3.5
	3.5 y	97.3	101.3**	4.0	4.1	94.6	99.5**	4.9	5.2	92.3	96.0**	3.7	4.0
	4.0 y	101.2	104.9**	3.7	3.7	97.8	103.1**	5.3	5.4	95.9	99.5**	3.6	3.8
	4.5 y	104.5	108.7**	4.2	4.0	101.0	106.2**	5.2	5.1	98.6	102.6**	4.0	4.1
	5.0 y	107.6	111.7**	4.1	3.8	104.3	109.7**	5.4	5.2	102.2	105.7**	3.5	3.4
	5.5 y	110.8	115.4**	4.6	4.2	106.9	112.7**	5.8	5.4	104.5	108.6**	4.1	3.9
	6~7 y	115.1	118.9**	3.8	3.3	111.3	116.5**	5.2	4.7	109.1	112.5**	3.4	3.1
	Average			2.4	2.7			3.2	3.7			2.3	2.8

Note. It: total increments of height from 1985 to 2005/2006 (cm); Ir: rate of It based on the 1985 measurements (%). *t*-test: * $P < 0.01$, ** $P < 0.001$.

Table 3. Secular Change in Chest Circumference of Chinese Children in Urban, Suburban and Rural Areas, 1985- 2005/2006

Sex	Age Group	Urban				Suburban				Rural			
		1985	2005	It (cm)	Ir (%)	1985	2005	It (cm)	Ir (%)	1985	2005	It (cm)	Ir (%)
	0-3 d	32.3	32.9**	0.6	1.9	32.5	32.8**	0.3	0.9	32.3	32.9**	0.6	1.9

(Contiued)

Sex	Age Group	Urban				Suburban				Rural			
		1985	2005	It (cm)	Ir (%)	1985	2005	It (cm)	Ir (%)	1985	2005	It (cm)	Ir (%)
Boys	1 m	37.3	37.5**	0.2	0.5	37.3	37.4*	0.1	0.3	36.7	37.2**	0.5	1.4
	2 m	39.8	39.9*	0.1	0.3	39.5	39.8**	0.3	0.8	38.8	39.2**	0.4	1.0
	3 m	41.2	41.5**	0.3	0.7	40.8	41.3**	0.5	1.2	40.1	40.9**	0.8	2.0
	4 m	42.3	42.4*	0.1	0.2	41.8	42.2**	0.4	1.0	41.0	41.9**	0.9	2.2
	5 m	43.0	43.3**	0.3	0.7	42.4	42.9**	0.5	1.2	41.7	42.6**	0.9	2.2
	6 m	43.9	43.9	0.0	0.0	43.4	43.7**	0.3	0.7	42.5	43.4**	0.9	2.1
	8 m	44.9	44.9	0.0	0.0	44.2	44.5**	0.3	0.7	43.3	44.4**	1.1	2.5
	10 m	45.6	45.7*	0.1	0.2	44.8	45.3**	0.5	1.1	43.8	45.1**	1.3	3.0
	12 m	46.2	46.6**	0.4	0.9	45.4	46.2**	0.8	1.8	44.7	46.0**	1.3	2.9
	15 m	47.1	47.3**	0.2	0.4	46.3	46.9**	0.6	1.3	45.5	46.7**	1.2	2.6
	18 m	47.8	48.1**	0.3	0.6	47.1	47.8**	0.7	1.5	46.4	47.6**	1.2	2.6
	21 m	48.4	48.9**	0.5	1.0	47.6	48.3**	0.7	1.5	47.2	48.2**	1.0	2.1
	2.0 y	49.4	49.6**	0.2	0.4	48.7	49.2**	0.5	1.0	48.3	48.9**	0.6	1.2
	2.5 y	50.2	50.7**	0.5	1.0	49.8	50.3**	0.5	1.0	49.3	49.8**	0.5	1.0
	3.0 y	50.9	51.5**	0.6	1.2	50.7	50.9**	0.2	0.4	50.2	50.6**	0.4	0.8
	3.5 y	51.9	52.5**	0.6	1.2	51.4	51.7**	0.3	0.6	51.0	51.4**	0.4	0.8
	4.0 y	52.3	53.4**	1.1	2.1	52.2	52.5**	0.3	0.6	51.8	52.0**	0.2	0.4
	4.5 y	53.0	54.4**	1.4	2.6	52.9	53.4**	0.5	0.9	52.4	52.7**	0.3	0.6
	5.0 y	53.8	55.5**	1.7	3.2	53.5	54.2**	0.7	1.3	53.3	53.3	0.0	0.0
	5.5 y	54.6	56.6**	2.0	3.7	54.2	55.0**	0.8	1.5	53.9	54.0*	0.1	0.2
	6~7 y	55.8	57.6**	1.8	3.2	55.2	56.0**	0.8	1.4	55.1	55.2*	0.1	0.2
	Average			0.6	1.2			0.5	1.0			0.7	1.5
Girls	0-3 d	32.2	32.6**	0.4	1.2	32.3	32.4*	0.1	0.3	32.1	32.6**	0.5	1.6
	1 m	36.5	36.6*	0.1	0.3	36.6	36.6	0.0	0.0	35.8	36.3**	0.5	1.4
	2 m	38.7	38.8*	0.1	0.3	38.5	38.7**	0.2	0.5	37.7	38.4**	0.7	1.9
	3 m	40.1	40.3**	0.2	0.5	39.7	40.2**	0.5	1.3	39.0	39.7**	0.7	1.8
	4 m	41.1	41.4**	0.3	0.7	40.6	41.1**	0.5	1.2	39.8	40.8**	1.0	2.5
	5 m	41.9	42.1**	0.2	0.5	41.4	41.8**	0.4	1.0	40.6	41.4**	0.8	2.0
	6 m	42.9	42.9	0.0	0.0	42.3	42.6**	0.3	0.7	41.3	42.3**	1.0	2.4
	8 m	43.7	43.9**	0.2	0.5	42.9	43.5**	0.6	1.4	42.2	43.3**	1.1	2.6
	10 m	44.4	44.6**	0.2	0.5	43.5	44.2**	0.7	1.6	42.7	44.1**	1.4	3.3
	12 m	45.1	45.4**	0.3	0.7	44.2	44.9**	0.7	1.6	43.6	45.0**	1.4	3.2
	15 m	45.9	46.2**	0.3	0.7	45.1	45.8**	0.7	1.6	44.5	45.7**	1.2	2.7
	18 m	46.7	47.0**	0.3	0.6	46.0	46.7**	0.7	1.5	45.3	46.6**	1.3	2.9
	21 m	47.3	47.8**	0.5	1.1	46.7	47.3**	0.6	1.3	46.1	47.2**	1.1	2.4
	2.0 y	48.2	48.5**	0.3	0.6	47.6	48.1**	0.5	1.1	47.3	47.9**	0.6	1.3
	2.5 y	49.1	49.6**	0.5	1.0	48.8	49.1**	0.3	0.6	48.4	48.7**	0.3	0.6
	3.0 y	49.8	50.5**	0.7	1.4	49.5	50.0**	0.5	1.0	49.3	49.5**	0.2	0.4
	3.5 y	50.6	51.3**	0.7	1.4	50.5	50.7**	0.2	0.4	50.0	50.1*	0.1	0.2
	4.0 y	51.2	52.1**	0.9	1.8	50.9	51.4**	0.5	1.0	50.7	50.9**	0.2	0.4
	4.5 y	52.0	53.0**	1.0	1.9	51.6	52.0**	0.4	0.8	51.3	51.5**	0.2	0.4
	5.0 y	52.4	53.7**	1.3	2.5	52.1	52.8**	0.7	1.3	52.0	52.1*	0.1	0.2
	5.5 y	53.2	54.8**	1.6	3.0	52.8	53.6**	0.8	1.5	52.7	52.9**	0.2	0.4
	6~7 y	54.1	55.8**	1.7	3.1	53.9	54.5**	0.6	1.1	53.7	53.7	0.0	0.0
	Average			0.5	1.1			0.5	1.0			0.7	1.6

Note. It: total increments of chest circumference from 1985 to 2005/2006 (cm); Ir: rate of It based on the 1985 measurements (%). *t*-test: * $P < 0.01$, ** $P < 0.001$.

Table 4. Urban-suburban and suburban-rural difference in weight of Chinese children (kg)

Age Group	Boys				Girls			
	1985		2005/2006		1985		2005/2006	
	Ur-subur	Subur-rural	Ur-subur	Subur-rural	Ur-subur	Subur-rural	Ur-subur	Subur-rural
0-3 d	-0.01	0.05	0.02	0.05	0.01	0.05	0.05	0.02
6-8 m	0.34	0.32	0.18	0.35	0.30	0.29	0.15	0.32
12-15 m	0.53	0.37	0.38	0.43	0.53	0.29	0.35	0.36
2.0-2.5 y	0.63	0.31	0.53	0.73	0.68	0.36	0.56	0.70
3.0-3.5 y	0.53	0.41	0.66	0.91	0.65	0.36	0.58	1.10
4.0-4.5 y	0.67	0.40	0.88	1.12	0.89	0.36	0.84	1.18
5.0 -5.5 y	0.93	0.46	1.44	1.46	0.85	0.49	1.09	1.41
6.0~7.0 y	1.47	0.41	1.71	1.72	1.16	0.54	1.44	1.75

Table 5. Urban-suburban and suburban-rural difference in height of Chinese children (cm)

Age Group	Boys				Girls			
	1985		2005/2006		1985		2005/2006	
	Ur-subur	Subur-rural	Ur-subur	Subur-rural	Ur-subur	Subur-rural	Ur-subur	Subur-rural
0-3 d	0.0	0.1	0.0	0.4	0.0	0.1	0.0	0.4
6-8 m	1.1	1.0	0.5	1.5	1.0	1.0	0.5	1.2
12-15 m	1.6	1.1	0.8	2.1	1.7	1.0	1.0	1.7
2.0-2.5 y	2.5	1.6	1.7	3.2	2.8	1.7	1.6	3.2
3.0-3.5 y	2.6	2.0	1.7	3.3	3.2	1.6	1.4	3.7
4.0-4.5 y	3.1	1.8	2.0	3.3	3.4	1.9	1.8	3.6
5.0 -5.5 y	3.3	2.2	2.3	3.9	3.3	2.1	1.9	4.0
6.0~7.0 y	4.4	1.9	2.6	3.9	3.8	2.2	2.4	4.0

DISCUSSION

Some regional and national surveys on children growth have been conducted[10,14-18] since the establishment of the People's Republic of China in 1949. The accumulated data show that a remarkable positive secular trend in height and weight has been observed in Chinese children and adolescents during the recent decades, which reflects that the social environmental situation and economic developme ntal level have played important roles in human growth and development[19]. There has been several reports on the secular changes in growth of Chinese children, most of which have described the growth of children above 7 years of age[15-16], but nosystemic analysis has been recently reported on this topic for children under 7 years of age besides the 10-year change presented[10]. So the present study is the first one to compare the secular trends of Chinese children under 7 years of age living in three different kinds of socio-economic areas. The study data has very good comparability and represent ativeness because it comes from two series of large national surveys carried out in the same period and with the similar methods during the past 2 decades.

Compared with the results in 1985, the mean weight and height of all the children except newborns had been greatly improved after the 20 years apart. Between 1985 and 2005, the total increments of weight were 2.51 kg for urban boys and 2.14 kg for urban girls at ages of 5-5.5 years with an increment per decade of 1.26 kg and 1.07 kg respectively, 2.00 kg and 1.91 kg for suburban boys and girls with an increment per decade of 1.00 kg and 0.96 kg respectively. Similarly, the total increments of height were 4.5 cm for urban boys and 4.1 cm for urban girls with an increment per decade of 2.3 cm and 2.1 cm respectively, 5.4 cm for both suburban boys and girls with a growth rate of 2.7 cm per decade. During 1985 to 2006, the weight and height increments of rural boys and girls at ages of 5-5.5 years were 1.0 kg, 0.99 kg, 3.7 cm and 3.5 cm within the 21 years, and the corresponding increment per decade were 0.48 kg, 0.47 kg, 1.8 cm and 1.7 cm respectively. These comparative results

Table 6. Comparison of Increment Per Decade in Growth of Chinese Children in Urban, Suburban and Rural Areas, 1985-2005/2006

		Weight(kg)			Height(cm)			Chest circumference(cm)		
Sex	**Age Group**	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Boys	0-3 d	0.06	0.05	0.05	0.1	0.1	0.0	0.3	0.1	0.3
	2-3 m	0.13	0.17	0.10	0.2	0.4	0.3	0.1	0.1	0.2
	6-8 m	0.18	0.26	0.23	0.6	0.9	0.6	0.0	0.2	0.4
	12-15 m	0.31	0.39	0.34	0.9	1.3	0.8	0.2	0.4	0.6
	2.0-2.5 y	0.48	0.52	0.30	1.7	2.1	1.2	0.1	0.3	0.3
	3.0-3.5 y	0.68	0.62	0.35	1.9	2.4	1.6	0.3	0.1	0.2
	4.0-4.5 y	0.88	0.77	0.40	2.0	2.5	1.6	0.6	0.1	0.1
	5.0 -5.5 y	1.26	1.00	0.48	2.3	2.7	1.8	0.9	0.4	0.0
	6.0~7.0 y	1.35	1.23	0.54	1.9	2.8	1.7	0.9	0.4	0.0
Girls	0-3 d	0.06	0.04	0.05	0.1	0.1	0.0	0.2	0.1	0.2
	2-3 m	0.11	0.14	0.17	0.2	0.3	0.5	0.0	0.1	0.3
	6-8 m	0.18	0.25	0.22	0.5	0.8	0.7	0.0	0.2	0.5
	12-15 m	0.28	0.36	0.31	0.9	1.2	0.8	0.1	0.3	0.7
	2.0-2.5 y	0.47	0.53	0.34	1.7	2.2	1.4	0.1	0.3	0.3
	3.0-3.5 y	0.68	0.72	0.33	1.7	2.6	1.5	0.4	0.3	0.1
	4.0-4.5 y	0.82	0.84	0.40	1.9	2.7	1.7	0.4	0.3	0.1
	5.0 -5.5 y	1.07	0.96	0.47	2.1	2.7	1.7	0.7	0.3	0.0
	6.0~7.0 y	1.24	1.10	0.47	1.9	2.6	1.6	0.8	0.3	0.0

indicate that the physical growth and nutritional status of the present Chinese children, regardless of their living in urban cities or rural villages, has been significantly improved during the 2 decades. Other three large nutrition surveys[20-22] also confirm this conclusion about the positive secular change of children growth in China. In addition, these increments of weight and height greatly exceeded those of Europeans [23-24], whose height increased by 1 cm /10 years and weight by 0.3 kg/10 years at ages of 5-7 years, suggesting the Chinese children are still at the stage of consistent accelerated growth trends.

Compared with the new WHO child growth standards[25], the growth level of urban boys and girls had exceeded the WHO standards slightly for weight by 0.1-0.8 kg, height by 0.3-1.6 cm; the weight and height of suburban rural children above 1.5 years of age were slightly lower than the WHO's, but the difference was small and the average growth level reached or was close to the WHO's. Although the conditions of growth and nutrition of rural children had been more improved than that seen 21 years ago, they were still below the WHO's. For example, the mean weight and height of boys were lower than the WHO's by 1.63 kg and 4.0 cm at ages of 4 to 5 years. This finding shows that the growth level of urban children in China has reached that of developed countries, while the nutritional status of rural children need to be further improved and there is still much space to increase their growth.

In China, the huge difference in socio-economic development between urban and rural areas is a long-existing historical problem. The urban-rural difference in growth can be observed not only in children but also in adolescents[26] and adults[27]. However, there are some noticeable changes according to comparison of the 1985 and 2005 NGSCNCC. The urban-suburban difference in height was becoming smaller as the increasing rate of suburban children was faster than their urban peers. This narrowing trend would be continuing in the next decade; and the urban-suburban difference may disappear someday with the equality of socio-economic environment and urbanization of suburban rural areas. Unfortunately, the urban-suburban difference in weight became larger gradually among children above the age of 3 years as a result of the excessive weight increment of urban

children, especially boys. At the same time, the prevalence of overweight and obesity rose very rapidly in the same age range and same regions[28].

The suburban rural areas surround the urban cities, so in the current study, the suburban children represent the relative good nutritional rural population and their living conditions are much better than their pure rural peers. There was a significant growth difference between the suburban and the rural children in 1985, which became larger after the 21 years' interval. This may attribute to relatively slow economic growth and poor living conditions in rural areas. The reports of the National Statistics Bureau[29] show that the per capita disposable income of urban residents increased by 13-fold while just 7-fold for rural farmers during 1985 to 2005. The inequitable income suggests unbalanced social-economic development in different regions. The national nutrition and health survey[30] indicates that the dietary quality of Chinese residents has been improved, but there is significant difference between the urban and rural areas from 1982 to 2002. Energy and nutrient intakes can also substantiate the positive changes observed and the clear differences in growth among urban, suburban and rural children. For example, dietary protein, vitamin A and calcium intakes of urban children were higher than those of rural children aged 2-7 years in 2002[20]. An implication from intervention trials demonstrated that appropriate complementary feeding and micronutrient supplementation contributed to the improvement of infants and young children growth in rural areas of China[31-32]. With the urbanization process and the acceleration of new rural/countryside construction, the socio-economic status and living conditions will continue to be improved in all rural areas of China, and great changes in child growth and development can be expected in the near future.

DISCLOSURE STATEMENT

The authors have indicated that they have no financial relationships relevant to this article to disclose.

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