Special Article

EFFECT OF ECONOMIC REFORMS ON CHILD GROWTH IN URBAN AND RURAL AREAS OF CHINA

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ABSTRACT

Background Beginning in 1978, China implemented economic reforms to transform the economy to a free-market system. We compared the effect of the reforms on the growth of children in urban and rural areas.

Methods Using data from five large cross-sectional surveys conducted between 1975 and 1992, we examined the trends in height for age of children two to five years of age in urban and rural areas. Mean height for age was expressed as the height in centimeters adjusted to a reference value of 99.1 cm for a 42-month-old boy.

Results Height increased before and during the economic reforms. In 1975, the average height of children in periurban rural areas was about 3.5 cm less than that of children in urban areas. Between 1975 and 1985, the average height of children in periurban rural areas increased by 2.0 cm, as compared with 1.3 cm in urban children. Between 1987 and 1992, the average height of both urban and rural children increased, but the net increase for rural children was only one fifth that for urban children (0.5 vs. 2.5 cm). In a 1990 survey of seven provinces, the rural mean height was 92.5 cm, as compared with the urban mean of 96.9 cm and the reference value of 99.1 cm; 38 percent of rural children had moderate stunting of growth and 15 percent had severe stunting, as compared with 10 percent and 3 percent of urban children, respectively. Differences in height between rural and urban children were greater in provinces in which the average height of children was lower.

Conclusions Despite an overall improvement in child growth during the economic reforms in China, the improvement has not been equitable, as judged by increased differences in height between rural and urban children and increased disparities within rural areas. (N Engl J Med 1996;335:400-6.)

CHINA'S economic reforms have been in place for almost two decades. First initiated in rural areas in 1978, the reforms have now been implemented nationwide in order to transform the economy to a free-market system. The overall successes of these reforms in increasing the gross national product, average income, and personal expenditures are well recognized and widely praised.[1,2] In contrast to the wealth of economic and service statistics, however, there is a paucity of information on the impact of the reforms on health and nutrition. Although a number of large cross-sectional surveys of growth in children have been conducted in China, they have not been linked together to provide information on the patterns and trends of child growth in the context of the economic reforms.

The Chinese Nutritional Surveillance System was established in 1988 to collect, synthesize, and analyze nutritional information for national policy makers,[3,4] making it possible, for the first time in China, for the results of nutritional surveys conducted by different governmental agencies and organizations at different times to be brought together and compiled into compatible data sets to document the nutritional situation and its evolution. We used these data to describe trends in the growth patterns of Chinese children during the economic reforms. We focused specifically on the disparity between rural and urban growth trends, because reducing the gap in living conditions between these two areas has been a frequently declared goal of government planning and policies since 1949.[5,6]

METHODS

Data Sources

From 1975 to 1992, five large-scale cross-sectional surveys of growth in children that are relevant to our study were conducted in China (Table 1). Two Nine City and Periurban Rural Area Sur-

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TABLE 1. CHARACTERISTICS OF FIVE SURVEYS OF CHILD GROWTH IN CHINA, 1975–1992.*

CHARACTERISTIC	NCPRAS	NCPRAS	NPCGS	SPNSPS	NCGS
Date of survey	1975	1985	1987	1990	1992
Purpose	To establish standards for child growth and development	To replicate the 1975 survey and increase the size of the survey	To assess the nutrition and health status of children	To assess the nutrition and health status of children and establish a national surveillance system	To assess the nutrition and health status of children
Areas covered	The cities of Beijing, Harbin, Xian, Shanghai, Wuhan, Nanjing, Guangzhou, Fuzhou, and Kunming and the surrounding rural areas	The cities and surrounding rural areas included in the 1975 survey as well as 18 cities of varying sizes and 26 typical rural counties	Urban and rural areas of 9 provinces: Heilongjiang, Zhejiang, Shandong, Hubei, Guangdong, Sichuan, Yunnan, Ningxia-Hui, and Neimong (Inner Mongolia)	Urban and rural areas of 7 provinces: Beijing, Hebei, Heilongjiang, Zhejiang, Guangdong, Sichuan, and Ningxia-Hui	Twenty-nine of the 30 mainland provinces†
Age range (yr)	0 to 17	0 to 7	0 to 17	0 to 6	0 to 14
Sample size	270,000	285,000	91,000	5100	615,000
Data collected	Age, sex, anthropometry, eating habits, and developmental stage	Age, sex, anthropometry, eating habits, and developmental stage	Age, sex, anthropometry, health, education, and environmental factors	Age, sex, anthropometry, health, education, and household characteristics	Age, sex, anthropometry, health, education, and environmental factors

*NCPRAS denotes Nine City and Periurban Rural Area Survey, NPCGS Nine Province Child Growth Survey, SPNSPS Seven Province Nutrition Surveillance Pilot Survey, and NCGS National Child Growth Survey.

†Tibet was excluded for logistic reasons.

veys with comparable data were conducted in 1975 and 1985 by the Capital Institute of Pediatrics and the Ministry of Health.[7-9] They measured all children on randomly selected streets of nine cities — Beijing, Harbin, Xian, Shanghai, Wuhan, Nanjing, Guangzhou, Fuzhou, and Kunming — and surrounding rural townships.

Three surveys, the 1987 Nine Province Child Growth Survey, the 1990 Seven Province Nutrition Surveillance Pilot Survey, and the 1992 National Child Growth Survey, conducted by the State Statistical Bureau had comparable data for five provinces (Guangdong, Heilongjiang, Ningxia-Hui, Sichuan, and Zhejiang), spanning the period from 1987 to 1992.[3,8,10-12] The 1987, 1990, and 1992 surveys included data on 9, 7, and 29 provinces or cities, respectively. These multistage surveys measured all children in random clusters of streets or villages. The provincial rural and urban samples were proportional to the sizes of the populations represented. Table 1 provides further information about the surveys.

Geographically, the five surveys cover the most populous regions from the north to the south of China, and data are comparable within the two periods but not between them. Apart from the sampling designs of the studies, major differences are the larger size of the urban areas and the more periurban nature of the rural areas in the earlier period, in contrast to the more representative samples in the later period.

Measurements of Child Growth

Height for age was used to evaluate growth. In all surveys, standing heights were measured and information on age and sex was obtained according to the standardized procedure of the World Health Organization (WHO).[13] The mean height for age was derived from the prevalence estimates available from the 1992 National Child Growth Survey.[12,14] Height values from the other surveys were converted into z scores relative to the reference data of the Centers for Disease Control and Prevention (CDC) and the WHO[15,16] for statistical analyses, because the z scores permit height values to be compared and summarized across age and sex groups.[17,18] Sex-specific z scores were pooled, since differences in height between the sexes were small (z score, <0.12) and the secular changes in height were similar. The mean height for age was calculated for each survey from the provincial means weighted according to the provincial populations. To present the results, we converted the z scores back to height (in centimeters) relative to that of a 42-month-old boy representing the sample mean and the CDC–WHO standard (99.1 cm). Thus, this age-adjusted value summarized the height values of all the children in the study.

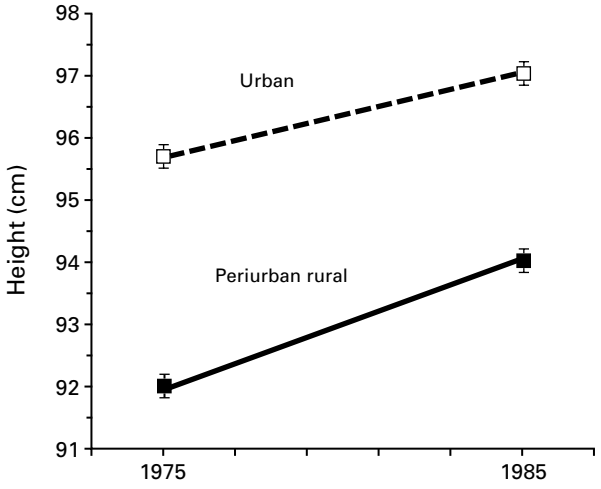
We restricted our study to children 2 through 5.9 years of age (24 to 72 months) because the rate of growth retardation among Chinese children,[19] like that among children in many other developing countries,[20] is high before 2 years of age but stabilizes thereafter. Thus, the height of a two-year-old reflects all the negative effects due to actively stunted growth that have occurred in the previous two years. Focusing the analysis on children two to five years old whose growth had stabilized decreased the influences due to the varying proportions of younger children with active growth retardation across surveys and increased the responsiveness of growth indexes to longer-term socioeconomic changes. However, the timing of the effect on height precedes that of the response as measured in the survey by two to five years.

Statistical Analysis

Data were checked for height outliers in all surveys. Height outliers, defined as z scores for height for age that were greater than 6 or less than -6 (a deviation of 25 cm from the sample mean for a 42-month-old boy), were deleted. The proportion of these outliers ranged from 5 to 10 per 1000 observations across surveys.

To measure the variability in height within populations after the economic reforms, we used distribution parameters from the 1990 Seven Province Nutrition Surveillance Pilot Survey, because anthropometric measurements in this survey were standardized and reliability was documented directly by two of us through systematic training before the survey and unannounced remeasurements of 5 percent of rural and urban subjects during the survey. The interobserver unreliability[21] between the replicate measurements taken in the field was 0.52 cm^2 (coefficient of variation, 0.56 percent), with no significant differences found between rural and urban samples and between rich and poor areas.[22]

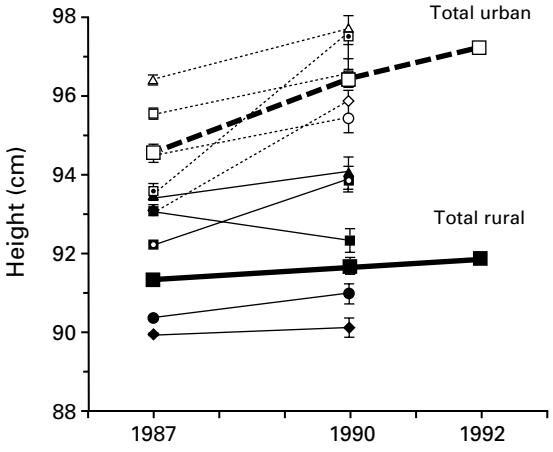
Analyses of variance were used to evaluate the differences between rural and urban scores and secular trends. The difference in



No. of Children		
Urban	36,058	28,800
Rural	35,001	28,800

Figure 1. Mean (±SE) Height of Chinese Children in Urban and Periurban Rural Areas, According to the 1975 and 1985 Nine City and Periurban Rural Area Surveys.

Data on children 24 to 72 months of age were pooled and adjusted to the reference value.



No. of Children (Urban/Rural)		
▣/◘ Ningxia-Hui	912/3283	101/220
◇/◆ Sichuan	1843/8090	199/500
○/● Guangdong	1334/7574	181/568
△/▲ Zhejiang	1441/3990	140/220
□/■ Heilongjiang	1265/4204	252/382

Figure 2. Mean (±SE) Height of Chinese Children in Urban and Rural Areas According to Province, 1987–1992.

Data on children 24 to 72 months of age were pooled and adjusted to the reference value. Data were obtained from the Nine Province Child Growth Survey (1987), the Seven Province Nutrition Surveillance Pilot Survey (1990), and the National Child Growth Survey (1992).

secular trends between urban and rural children was evaluated by the interaction in the analysis of variance between trend and the rural–urban contrast. In the 1990 Seven Province Nutrition Surveillance Pilot Survey, the differences between urban and rural children in the prevalence of stunting and variability of height distribution were evaluated respectively by the chi-square test and the F test for heterogeneity of variances.[23] To investigate relations between provincial mean urban and rural growth patterns and between the within-population variability and the mean of the measurements, regression analyses were undertaken across provinces.

RESULTS

Evolution of the Growth of Rural and Urban Children before and during the Early Stage of the Economic Reforms: 1975–1985

In 1975, before the economic reforms, the mean height of children in periurban rural areas was about 3.5 cm less than that of children in urban areas. The mean heights in the 1975 and 1985 Nine City and Periurban Rural Area Surveys are shown in Figure 1. During this 10-year period the average height of urban Chinese children increased by 1.3 cm (z score, 0.29; $P<0.01$) and of children in periurban rural areas by 2.0 cm (z score, 0.50; $P<0.01$). Thus, the differences in height between the groups narrowed by 0.7 cm (z score, 0.20; $P<0.01$).

Evolution of the Growth of Rural and Urban Children after the Economic Reforms: 1987–1992

A different picture emerged when surveys conducted between 1987 and 1992 were compared. Although the average height of both urban and rural children continued to increase, by 2.5 cm (z score, 0.63; $P<0.01$) and 0.5 cm (z score, 0.12; $P<0.01$), respectively (Fig. 2), the net increases in the height of rural children were only one fifth those of urban children. Thus, the differences between groups increased by about 2.0 cm (z score, 0.50) over the five-year period.

Provincial trends were consistent with the general trends. In most provinces, growth improved more in urban children than in rural children. The overlap in mean height between some urban and rural areas in different provinces in 1987 was no longer present in 1990 (Fig. 2). The increases in the differences between rural and urban children ranged from 0.3 cm (in Guangdong) to 2.5 cm (in Sichuan).

Characteristics of Rural and Urban Growth

In the 1990 Seven Province Nutrition Surveillance Pilot Survey, the mean height in rural areas was more than three times as far below the CDC–WHO standard (99.1 cm) as was the urban mean (Table 2). The rural height distribution, as measured by the standard deviation, was broader than that of the CDC–WHO reference value (4.0 cm) and that of urban children. There were also significant differences between rural and urban populations in the prevalence of stunting.

In spite of a large variation, the mean heights in

TABLE 2. DIFFERENCES IN HEIGHT DISTRIBUTIONS OF CHINESE CHILDREN IN SEVEN PROVINCES IN 1990.*

POPULATION	NO. OF CHILDREN	HEIGHT		CHILDREN WITH MODERATE STUNTING OF GROWTH†	CHILDREN WITH SEVERE STUNTING OF GROWTH‡
		MEAN	SD		
		cm		percent	
Urban	1162	96.9	5.02	10	3
z Score		−0.5	1.24		
Rural	2636	92.5	5.8	38	15
z Score		−1.6	1.4		
Difference§		4.5¶	0.7¶	28¶	12¶
z Score		−1.1	0.2		

*All children were 24 to 72 months of age. Heights were expressed relative to the reference value of 99.1 cm for a 42-month-old boy.

†Moderate stunting of growth was defined as a z score below −2.

‡Severe stunting of growth was defined as a z score below −3.

§Differences between means were tested by analysis of variance; differences between prevalence estimates were tested by the chi-square test; the difference between standard deviations was tested by the F test of variances.

¶$P<0.001$.

rural and urban areas within provinces were closely correlated ($r=0.96$, $P<0.01$) across the seven provinces (Fig. 3). The differences in height between rural and urban areas were greater in provinces in which the average height of children was shorter (i.e., the distance between the expected and fitted regression lines increased as the average height of rural or urban children decreased) ($P<0.05$).

Figure 4 depicts the variations in mean height within each provincial urban and rural group, expressed as the distance between the 10th and the 90th percentile values of distributions. The extent of the variations in height increased as the mean height decreased ($P<0.01$), and this pattern was similar in both urban and rural areas ($P>0.40$ for the interaction). The difference in height between children in the top 10 percent and the bottom 10 percent of a population in the province with the lowest mean height was 2.0 cm (z score, 0.5; $P<0.01$) greater than the difference in the same measure in the province with the highest mean height.

DISCUSSION

Differences between the CDC–WHO standards for growth in children and the actual physical growth of children in developing countries, as measured by assessing height for age, are mainly due to a combination of inadequate dietary intake and frequent infectious disease, both rooted in low social status and poverty.[18,24] These relations between child growth and its underlying socioeconomic determinants permit the use of growth as a summary indicator of overall social development in areas in which the achievement of genetic potential in physical growth is limited by these determinants. Because of the complicated nature of social processes, growth in children may not be a useful indicator of the specific aspect of socioeconomic development that causes adequate growth, but it can reveal whether socioeconomic development as a whole is effective and equitable across affected populations.[18]

The growth of Chinese children was improving before the economic reforms were initiated in 1978,[4] and they continued to improve throughout the period examined in the study. These secular trends indicate the overall effectiveness of long-term socioeconomic development in China and the general success of government policies in transforming economic wealth into sustained increases in health and nutritional status, but they say nothing about the distribution of these changes across groups. Rural children, who make up the majority of Chinese children, grow much less well overall than their urban counterparts.[4,10,12,25,26] Therefore, we examined whether improvements in growth have decreased these differences between urban and rural children.

The difference in height between periurban rural areas and large cities was reduced by 0.7 cm (z score, 0.20) among children born during 1980 to 1983, as compared with those born during 1970 to 1973 (according to surveys conducted in 1985 and 1975, respectively). Although the height values were about 2 cm higher (z score, 0.49) in the two Nine City and Periurban Rural Area Surveys than they would have been if more representative urban and rural samples had been obtained, the overall changes in

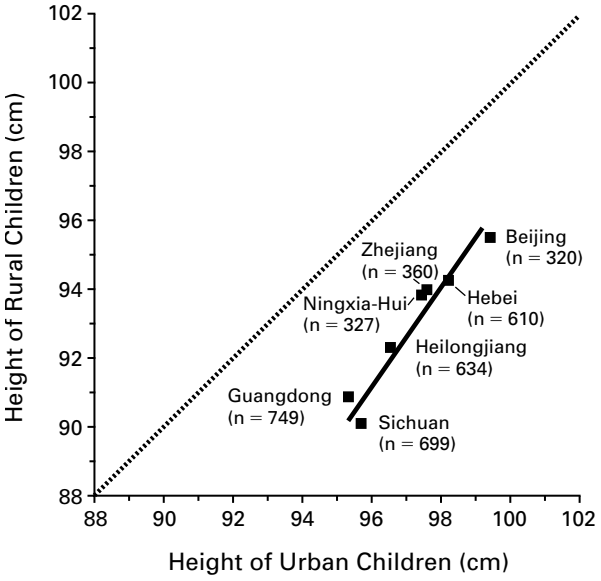


Figure 3. Mean Height in Urban and Rural Areas in Seven Provinces, 1990.

Data on children 24 to 72 months of age were pooled and adjusted to the reference value. The expected and predicted regression lines are shown. The urban value was used as the independent variable, and the rural value was used as the dependent variable.

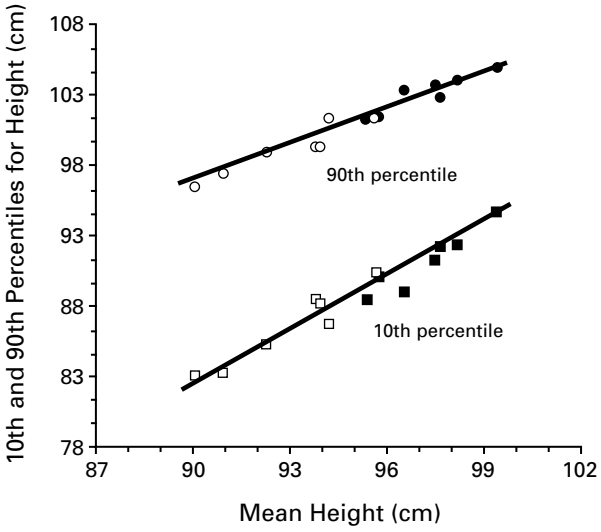


Figure 4. Relations between the Mean Heights in Rural Areas (Open Symbols) and Urban Areas (Solid Symbols) in Seven Provinces and the 10th and 90th Percentile Values of Height Distributions, 1990.

The predicted regression lines are shown.

height reflect those occurring in general in urban and rural areas during this period.[4,10,27] In contrast to the periods before and during the early stage of the economic reforms, after the reform period there was a significant increase of 2 cm (z score, 0.49) in the difference in height between urban and rural areas among children born during 1982 to 1985, as compared with those born during 1987 to 1990 (according to surveys conducted in 1987 and 1992, respectively).

The greater improvement of rural children's health and nutrition relative to that of urban children in the first period and the greater improvement among urban children but relative (although not absolute) deterioration among rural children in the second period may be explained as follows. The first survey period corresponded to the end of the 10-year "cultural revolution" (1966 to 1976) and the government's emphasis on social stability. From 1977 to 1987, the proportion of the rural population living in poverty (defined as an income of less than 200 yuan [$53] per capita in 1985) declined; rural household income increased by 110 percent, and urban income by 85 percent.[2] The widened differences in growth between rural and urban children in the second period were probably related to several important economic and health effects of the reforms, which were initiated in the middle of the first period.

Since 1985, after the initial development of the rural economy during the early stage of the reforms, urban areas have developed more rapidly than rural areas. The urban-to-rural ratio of total expenditures per capita, a relatively reliable estimate of differences in income between urban and rural areas, increased from 2.2 during the 1980s to more than 3 in 1992.[28,29] This change corresponded to increased urban employment and investment opportunities and relatively unchanged government procurement prices for agricultural products, but substantial increases in the prices of manufactured materials used in agriculture, such as fertilizer and pesticide.[30,31] These economic changes were also responsible for the lack of change in the number of rural inhabitants who were living below the state-defined poverty line after 1985.[30,32] The range of the changes between rural and urban populations across provinces was probably related to the fact that the economic reforms were not initiated at the same time or to the same degree in all provinces. The largest increase (2.5 cm) in the difference in height between rural and urban children from 1987 to 1990 was in Sichuan, a leading province in the introduction of the reforms.

Perhaps the most pronounced change since the early 1980s has been in the rural health care system. The economic reforms have resulted in the disintegration of the rural cooperative medical systems, the disappearance of "barefoot doctors," and despite an initial increase, a sharp reduction in the amount of

government health care expenditures for preventive services and maternal and child health care, all of which had been essential elements in the improvement of health status in rural China since the 1960s.[27,33-36] These changes did not occur in urban areas, since health care continued to be subsidized after the reforms.[37]

The height distributions of rural and urban children in 1990 were characterized by a strong negative relation between the mean and measures of variation. Both the differences between rural and urban areas and the spread were larger in provinces with lower mean heights. These relations did not result from effects of scale, since such effects are absent in height measurements over a wide range of values.[21] Differences in the reliability of measurements could explain these differences, but this possibility can be excluded because of the consistency of the values shown in Figure 4. The most likely explanation is that the widened distribution of height with lower heights reflects a combination of lessened genetic restrictions on height and a more inequitable distribution of the economic resources for nutrition and health in childhood.

Our results contradict other findings,[38] including those in a recent report by the WHO, which indicated that the variation in height for age is constant across populations regardless of the mean.[18] Our data were highly standardized, and we investigated the variation in distributions using the distance between percentile values rather than the standard deviation. The differences in the variation were less evident, although still significant ($P<0.05$), when expressed as the standard deviation.

In summary, our findings indicate a continuous overall improvement in the growth of children during the economic reforms in China. However, the improvement has not been the same in all parts of the country, as judged by increased differences in height between rural and urban children and increased disparities in height within rural areas. These changes in growth differentials were probably related to differences in socioeconomic development between rural and urban populations and an uneven distribution of resources to and within rural areas. It is even possible that some rural populations are less well off in terms of health and nutrition than they were 20 years ago. This is contrary to the explicit intent of Chinese policy, which aims to favor rural development.

Future economic reforms in China should pay more attention to issues of equal opportunities for socioeconomic development through a more equitable distribution of development resources. Also, direct nutrition and health interventions and other compensatory measures could be designed to target rural populations, particularly rural poor populations, to mitigate the potentially negative effect of economic reforms on nutrition. In either case, continuously monitoring the evolution of the situation, providing timely information to national policy makers, and advocating more equitable development policies are essential.

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