

## ORIGINAL ARTICLE

# Under- and overnutrition dynamics in Chinese children and adults (1991–2004)

T Dearth-Wesley<sup>1</sup>, H Wang<sup>2</sup> and BM Popkin<sup>1</sup>

<sup>1</sup>Department of Nutrition and Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA and

<sup>2</sup>Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, Beijing, China

**Objective:** To examine trends in under- and overweight prevalence from 1991 to 2004 among adults and children in China by income and residence differentials.

**Methods/Subjects:** Prevalence, average annual changes and annual relative changes in under- and overweight were determined. In 1991, 2848 children and 6806 adults were surveyed. The 2004 survey included 1566 children and 6172 adults.

**Results:** Higher average annual reductions in underweight prevalence were found among children, particularly rural children, when compared with adults. With respect to income, low-income children and adults experienced the greatest average annual reductions in underweight prevalence. The trend for increased overweight was more pronounced than the trend for decreased underweight. Intensified trends were found among adults (versus children) and males (versus females). Relative to baseline prevalence, overweight increased fastest among adults in low-income and rural populations.

**Conclusions:** Rapid increases in the overweight prevalence, particularly as found among low-income and rural Chinese adults, will likely lead to a shift in the burden of obesity-related chronic diseases toward the poor. Associated economic and health implications will further challenge the country's health care system, restrain economic development and widen existing disparities between the rural and urban as well as between the rich and poor populations of China.

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## Introduction

The global shift toward increased obesity has been extensively documented (Haslam and James, 2005; Popkin, 2006). At the same time, undernutrition has persisted in developing countries (Ge and Fu, 2001). Collectively, these nutritional concerns characterize the dual burden of under- and overnutrition (Griffiths and Bentley, 2001; Monteiro *et al.*, 2004; Doak *et al.*, 2005). There is limited research investigating the sociodemographic dimensions of shifts in under- and overnutrition (that is, the dual burden), with one exception that examined nutritional trends in Brazilian preschoolers and adults by income level (Monteiro *et al.*, 2002). Exploration of the double burden of under- and overnutrition in China by

income and residence differentials is opportune, given the country's rapid economic changes and growing inequities between urban and rural residents (State Statistical Bureau, 2004; World Bank, 2005).

Impressive and sustained socioeconomic development in China over the past two decades has yielded varied effects on the nutritional status of its people. Some research has shown reductions in undernutrition, but more focus has been placed on identifying factors responsible for hastening the stage of the nutrition transition to one dominated by nutrition-related noncommunicable diseases (NCDs) (Chang *et al.*, 1994; Gu *et al.*, 2005; Wang *et al.*, 2006a, b). One factor contributing to the shift toward NCDs is improved income, which can have detrimental effects on dietary intake. Improvements in income are associated with decreased consumption of traditional foods (for example, rice, wheat and wheat products) and increased consumption of edible oils and animal foods (Popkin *et al.*, 1995; Popkin and Du, 2003; Du *et al.*, 2004). These dietary shifts are occurring across all income groups in China, with many of the greatest changes happening at the low- and middle-income levels.

Correspondence: Dr BM Popkin, Carolina Population Center, University of North Carolina at Chapel Hill, CB # 8120 University Square, 123 West Franklin Street, Chapel Hill, NC 27516-3997, USA.

E-mail: popkin@unc.edu

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A resulting shift in the burden of overweight, obesity and diet-related NCDs from the rich to the poor Chinese is anticipated (Du *et al.*, 2004). More detailed examination of nutritional status changes occurring among adults and children could elucidate the direction that trends in under- and overweight are heading for China's urban and rural as well as rich and poor populations.

Emphasis on residence and income differentials is important—given the increased economic and health inequities between China's urban rich and rural poor (Blumenthal and Hsiao, 2005). Higher wealth deciles consist primarily of urban residents, while rural residents constitute greater proportions of the lower wealth deciles (United Nations Development Program, 2005). Thus, the rural poor are most challenged by recent and rapid rises in the cost of health care in China. Not only is the cost of care increasing, but also the health care coverage is declining in both rural and urban areas. Only 20% of rural and 55% of urban Chinese were insured in 2003 (World Bank, 2005). A potential shift in the burden of overweight and obesity from the rich to the poor would exacerbate existing inequities between China's urban rich and rural poor and place increasing demands on the country's faltering health care system.

This paper builds on earlier research to examine in-depth trends in under- and overweight prevalence among adults and children in China by income and residence groupings. Particular emphasis is placed on understanding the relative effects of these shifts on the rural and poor to better comprehend the direction of the nutritional changes.

## Methods

### Data

Cross-sectional data from the China Health and Nutrition Survey (CHNS) were used (Du *et al.*, 2004). The CHNS utilized a multistage, randomized cluster design conducted in nine Chinese provinces to study implications of socio-economic development and government policies and programs on the health and nutritional status of the Chinese population. In spite of the CHNS not being a nationally representative survey, previous findings on body composition and dietary trends strongly correlate with survey results from national surveys and the China National Bureau of Statistics (Ge *et al.*, 1996).

Study participants included children, aged 6–17.9 years, and adults, aged 18–54.9 years, surveyed in 1991 and 2004. Based on the age range criteria, the 1991 survey included 2848 children (1386 females; 1462 males) and 6806 adults (3585 females; 3221 males). In 2004, 1566 children (738 females; 828 males) and 6172 adults (3224 females; 2948 males) were surveyed. Study variables consisted of age, gender, weight, height, urban-rural residence status and adjusted per capita household income.

### Measures

Date of birth (converted to age based on survey date) and gender variables were self-reported by survey participants in the interviewer-administered household questionnaire. Weight and height were directly measured by trained nutritionists. Weight was measured to the nearest 0.1 kg by using a calibrated beam scale with participants wearing light clothing and no shoes. Height was measured without shoes to the nearest 0.2 cm by using a portable stadiometer. Weight divided by height squared ( $\text{kg}/\text{m}^2$ ) determined body mass index (BMI). For children, underweight comprises BMI-for-age <5th percentile and overweight  $\geq$ 85th percentile based on the 2000 National Center for Health Statistics (NCHS) Growth Charts. Stunting is defined as <5th percentile based on the 2000 NCHS Growth Charts. BMI cut-offs for adults as defined by the WHO standards are underweight <18.5  $\text{kg}/\text{m}^2$  and overweight plus obesity  $\geq$ 25  $\text{kg}/\text{m}^2$ .

Urban-rural residence status was defined based on the administrative district. The income measure came from a detailed measure of all household activities that involved cash or kind payments. A deflated household per capita income measure was determined for each time point by dividing the income measure by the consumer price index.

The prevalence of under- and overweight was obtained for children and adults with stratification by gender, income and residence. Average annual and annual relative changes in under- and overweight prevalence were also examined. The average annual change in prevalence was calculated by dividing the prevalence difference between the two time points by the number of years between the two time points (that is, 13). Annual relative change in prevalence was determined by dividing the average annual change by the baseline prevalence (that is, 1991 prevalence); the result was multiplied by 100 to get a percentage.

## Results

### Underweight trends

Table 1 provides a general overview of prevalence trends in stunting, under- and overweight among Chinese children and prevalence trends in under- and overweight among Chinese adults from 1991 to 2004. Male children experienced slightly higher average annual reductions in stunting and underweight prevalence over the 13 years as compared with female children (–1.71, –0.48%, respectively for males; –1.55, –0.36%, respectively for females), with similar relative rates of change in stunting and underweight across genders (–4.5, –2.9%, respectively for males; –4.2, –2.7%, respectively for females). Despite reductions in the prevalence of stunting and underweight, the 16.0% prevalence of stunting and 9.4% prevalence of underweight among children in 2004 indicate that undernutrition remains a public health problem for Chinese children.

While underweight remained most prevalent among low-income adults over the years, low-income adults had

**Table 1** Change in the stunting, under- and overweight prevalence of Chinese children (6–17.9 years) and in the under- and overweight prevalence of adults (18–54.9 years) from 1991 to 2004

	Number of subjects			Stunting and underweight prevalence among children and underweight prevalence among adults			Overweight, plus obesity, prevalence			
	1991	2004	1991	2004	Average annual change	Annual relative change (%)	1991	2004	Average annual change	Annual relative change (%)
<b>Children</b>										
Females	1386	738								
Stunting			36.7	16.5	-1.55	-4.2	6.9	12.3	0.42	6.0
Underweight			13.2	8.5	-0.36	-2.7				
Males	1462	828								
Stunting			37.7	15.5	-1.71	-4.5	7.7	13.8	0.46	6.0
Underweight			16.4	10.1	-0.48	-2.9				
Total	2848	1566								
Stunting			37.2	16.0	-1.63	-4.4	7.3	13.1	0.44	6.0
Underweight			14.8	9.4	-0.42	-2.8				
<b>Adults</b>										
Females	3585	3224								
Stunting			9.3	5.5	-0.29	-3.2	13.4	26.2	0.99	7.4
Underweight			8.1	4.8	-0.26	-3.2	8.6	26.0	1.34	15.5
Males	3221	2948								
Stunting			8.8	5.2	-0.28	-3.2	11.1	26.1	1.15	10.4
Underweight										
Total	6806	6172								

**Table 2** Changes in under- and overweight prevalence of Chinese children (6–17.9 years) and adults (18–54.9 years) by income from 1991 to 2004

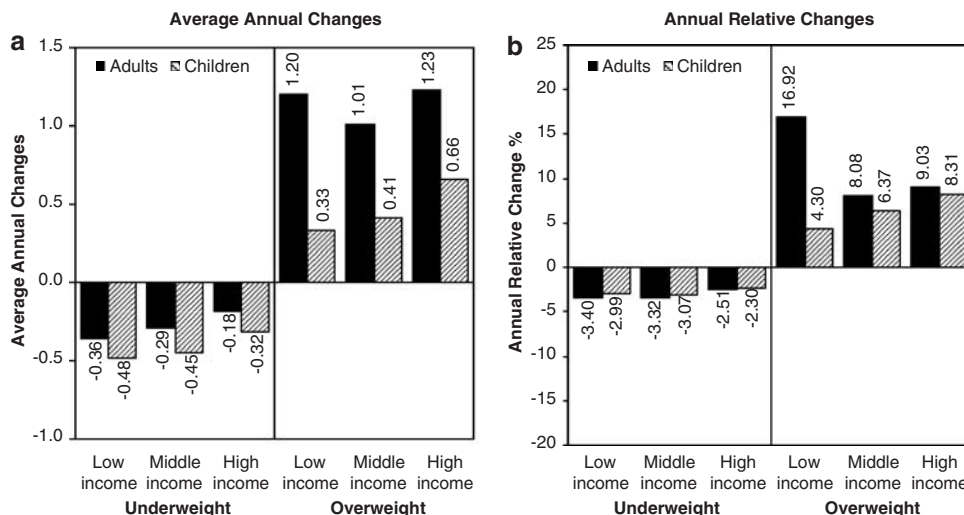
	Prevalence	
	1991	2004
<b>Underweight</b>		
<b>Children</b>		
Low income	15.9	9.7
Middle income	14.7	8.8
High income	13.9	9.8
<b>Adults</b>		
Low income	10.6	5.9
Middle income	8.7	5.0
High income	7.0	4.7
<b>Overweight</b>		
<b>Children</b>		
Low income	7.6	11.8
Middle income	6.5	11.9
High income	7.9	16.5
<b>Adults</b>		
Low income	7.1	22.8
Middle income	12.5	25.6
High income	13.6	29.6

the greatest average annual and annual relative changes in underweight prevalence from 1991 to 2004 (Table 2; Figure 1). Income level increases corresponded with decreases in both change measures for underweight prevalence among adults (Figure 1). With respect to urban-rural residence, average annual and annual relative changes were higher among rural (versus urban) children with only small differences in the change measures seen among rural adults versus urban adults (Table 3).

#### Overweight trends

Compared to declines in underweight, the trend toward increased overweight was more pronounced, particularly among adults. Average annual changes in overweight prevalence versus underweight prevalence were similar for children (0.44 and -0.42%, respectively) but four times greater for adults (1.15 and -0.28%, respectively). The trend toward increased overweight was more rapid for adults than children (1.15 and 0.44%, respectively), with male adults experiencing the highest rates of change (Table 1).

Positive relationships were found between income level and prevalence, average annual changes and annual relative changes in overweight among children, with the greatest rates of change among children in high-income households (Table 2; Figure 1). Low- and high-income adults had similar average annual changes in overweight, but the annual relative changes were much greater among low-income adults (Figure 1). Rural adults experienced notably higher average annual and annual relative changes as compared to urban counterparts (Table 3). In Figure 2, results for male adults by urban-rural residence and income level are



**Figure 1** Average annual and annual relative changes in under- and overweight prevalence from 1991 to 2004 for Chinese children aged 6–17.9 years and adults aged 18–54.9 years by income.

**Table 3** Changes in under- and overweight prevalence of Chinese children (6–17.9 years) and adults (18–54.9 years) by residence from 1991 to 2004

	Prevalence		Average annual change	Annual relative change (%)
	1991	2004		
<i>Underweight</i>				
<i>Children</i>				
Rural	15.4	9.3	-0.47	-3.1
Urban	13.0	9.7	-0.25	-1.9
<i>Adults</i>				
Rural	8.3	4.9	-0.26	-3.2
Urban	9.8	5.7	-0.32	-3.2
<i>Overweight</i>				
<i>Children</i>				
Rural	6.8	12.0	0.40	6.0
Urban	9.1	15.7	0.50	5.5
<i>Adults</i>				
Rural	8.8	24.9	1.24	14.2
Urban	16.4	28.4	0.93	5.7

presented. Average annual changes in overweight prevalence were highest among low- and high-income rural males, while annual relative changes were greatest among low-income, rural males.

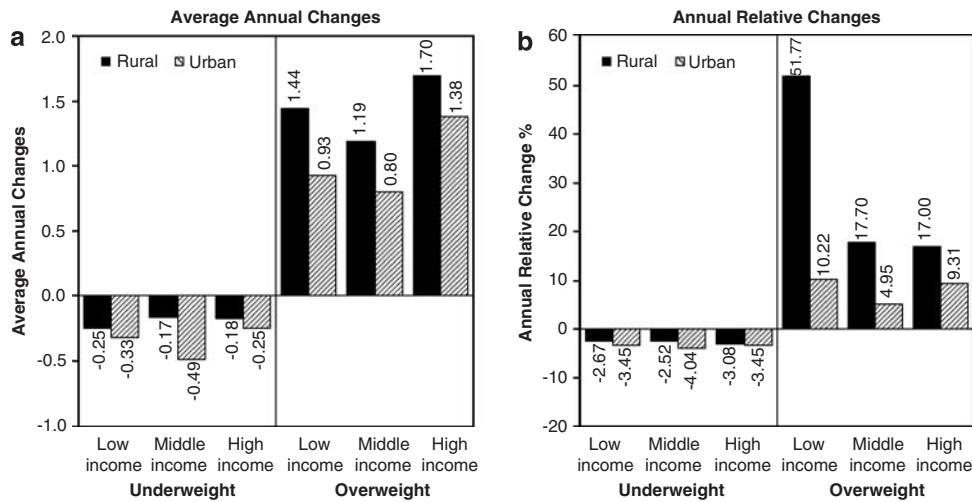
## Discussion

This study is unique in focusing on shifts in under- and overweight prevalence affecting both adults and children in China. Notable reductions in the prevalence of stunting and underweight among Chinese children correspond with other

studies indicating important improvements in the nutritional status of Chinese children over time (Wang *et al.*, 1998, 2007; Li *et al.*, 1999). However, the persistence of stunting and underweight among Chinese children demands sustained targeted efforts to promote optimal nutrition.

This study further documents how increases in overweight prevalence continue to outpace reductions in underweight prevalence among Chinese children and adults, and how the increasing prevalence of overweight is rapidly becoming a central public health concern among Chinese children and adults (Wang *et al.*, 2002; Mendez *et al.*, 2005). High prevalence estimates for overweight among Chinese children and adults are consistent with the findings from other surveys (Ge and Fu, 2001; Ji *et al.*, 2004; Wang *et al.*, 2006b). For Chinese adults, the nutritional burden has shifted to one primarily of nutritional excess. Interventions targeted at both children and adults and aimed at preventing future increases in overweight are crucial.

Compared with children, Chinese adults underwent greater changes in overweight prevalence over the years. Varying patterns of change in weight status for Chinese children and adults are hypothesized to be influenced by biological differences in adults and children, variations in how children and adults are affected by environmental change and possible interaction between biological and environmental factors (Popkin *et al.*, 2006). Increases in the overweight prevalence among adults have been linked with decreases in work- and transport-related physical activity, while a relationship between overweight and a high-fat, low-fiber diet has been found for both children and adults (Paeratakul *et al.*, 1998; Bell *et al.*, 2001, 2002; Wang *et al.*, 2003). More research is needed in order to better understand the relationship between weight status changes for children and adults.



**Figure 2** Average annual and annual relative changes in under- and overweight prevalence from 1991 to 2004 for Chinese rural and urban adult males aged 18–54.9 years by income.

Male children and adults experienced greater average annual changes in increased overweight as compared with female children and adults. This pattern is consistent with earlier research examining overweight trends for Chinese children (1991–1997) and adults (1989–2000) (Wang *et al.*, 2002, 2006a). The pattern is contrary to trend data from the 1980s showing increased overweight among Chinese women (Ge *et al.*, 1994; Paeratakul *et al.*, 1998; Wang *et al.*, 2006a). Explanations for the shift may be linked to an increasing desire for slimness among Chinese women or a preference given to males when allocating household resources (Lee, 1993; Lee *et al.*, 1996; Lee and Lee, 2000; Luo *et al.*, 2001; Fung and Yuen, 2003). Closer examination of socioeconomic factors and dietary and activity patterns with respect to gender would further clarify the role that gender plays in nutritional status changes.

Relative to baseline prevalence, overweight increased fastest among adults in low-income and rural populations. These findings are in agreement with the projection that the burden of overweight and obesity may shift from the rich to the poor, which was based on income growth and diet behavior research. Low-income adults experienced the greatest declines in the consumption of cereal foods and the most rapid increases in edible oil consumption from 1989 to 1997; future increases in income were expected to further negatively affect diet and body composition of the low-income Chinese (Du *et al.*, 2004). While a high-fat, low-fiber diet is one factor associated with overweight and obesity, our results support the accelerated trend toward increased overweight among low-income and rural adult populations. Our findings also show that the increased economic inequity in China has not meant increased undernutrition among the poor—a finding of trends in Chinese nutritional status found from research on economic change in the early 1990s (Popkin *et al.*, 1995).

The intensified trend toward increased overweight among adults in low-income and rural populations—particularly males—will likely lead to rises in obesity-related chronic diseases for China's rural poor. Direct costs associated with obesity-related chronic diseases will increasingly strain the weakened health care system in China. Indirect costs, such as absenteeism from work, will severely restrict China's economic development. Total costs associated with overweight and obesity in China were estimated at US \$49 billion in 2000 (4.06% of China's GNP), but these costs are predicted to escalate to US \$112 billion in 2025 (9.23% of China's GNP) (Popkin *et al.*, 2006). China must act quickly to curb continued increases in overweight and the associated economic costs. Special efforts must be taken to ensure that the nutritional interventions promoting optimal nutrition reach the rural poor. These health disparities are in addition to the extant economic inequities (State Statistical Bureau, 2004; World Bank, 2005). China cannot afford to have the economic and health disparities between its rural and urban and between its rich and poor populations widen any further and still expect to maintain the same level of noteworthy socioeconomic success.

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