Original Article

Lifespan nutrition and changing socio-economic conditions in China

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Background: Twenty-five years ago, China introduced sweeping reforms in the structure of its rural economy, family planning program, and financial accountability within enterprises and service sector organizations. A rapid rise in economic productivity has resulted in continuing increases in income and changes to the traditional Chinese diet.
Objective: The aim of this study is to examine how the social and economic transformation of China affects dietary patterns and nutritional status of people.
Design: The data from a prospective study, China Health and Nutrition Survey, begun in 1989 and followed up in 1991, 1993, 1997, 2000 and 2004. The population used in this study included 5000 subjects aged 18-45 from 4280 households in nine provinces. Dietary intakes were measured using a combination of the weighing method and three consecutive 24-h recalls. All other data were directly measured or obtained by in-depth interviews.
Result: The average consumption of all animal source foods except milk and eggs increased by 34g per capita per day, while the average intake of cereals decreased by 130g per capita per day. The proportion of animal source protein increased greatly and fat contributed an increasing proportion of energy. However, vitamin A and calcium intake did not increase from their low levels of intake during this period. Child height and weight increased and were linked with a decline in under nutrition. For example, the prevalence of overweight increased from 11.4% to 22.8% in women and from 6.4% to 25.1% in men in the same period, climbing much faster than before. The rapid shift in diet and obesity linked with social and economic changes in China continues unabated.
Conclusions: In association with the economic reform, the dietary pattern changed rapidly in these years.

Key Words: trends, nutrition transition, dietary pattern

Introduction

Twenty-five years ago, China introduced sweeping reforms in the structure of its rural economy, The economy has experienced exponential growth in the past decade, with per capita GDP rising from 460 yuan in 1980 to 9101 yuan in 2003[1]. Since 1990 the annual rate of per capita GDP growth has been 8.6 percent.[2] The number of employed persons has been steadily rising in the past decade, although the rising number and percent of unemployed, indicates that there needs to be an increased focus on job creation.[1] At the same time family planning program, and financial accountability within enterprises and service sector organizations. A rapid rise in economic productivity has resulted in continuing increases in income and changes to the traditional Chinese diet. But these changes are occurring at markedly different rates across the country. A post-reform China in the new millennium faces a range of challenges in health, nutrition, and family planning. The theory of the nutrition transition posits that these changes or stages relate to the complex interplay of changes in patterns of agricultural, health, nutrition status, food consumption and socio-economic factors.

The Chinese population has grown from 987 million to 1.292 million over the past three decades.[1] There has also been an increasing trend toward urbanization, with the percent of urban population growing from 19 to 40 percent. Birth and death rates have both been declining, while the natural growth rate has remained relatively stable. The Chinese population is becoming older, with a decrease in the percent of population 0-14 years of age and an increase in the percent of adults (15-64) and elderly (65 and above). Health indicators have improved over the past thirty years and nine out of ten Chinese adults are literate. While the population with access to safe sanitation has increased, it still remains low, below 50 percent.

Following rapid economic and social change, the pace of nutrition transition accelerated in China.[6,16,19] From the perspective of development, the effects of increased income have generally been viewed as beneficial, since higher income is associated with better quality diets, better health care, better child growth and so on.

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On the other hand, as income increases, dietary changes typically include higher energy and fat intakes, increased consumption of animal foods and processed foods. This chapter focuses on the interplay of demographic and economic changes with affect China's food demand and nutritional status.

Subject and methods

Data and study population

The data from China Economic, Population, Nutrition and Health Survey, which covers nine provinces, that varies substantially in geography, economic development, public resources, and health indicators. A multistage, random cluster sample was used to draw the sample surveyed in each of the provinces. Counties in the nine provinces were stratified by income (low, middle, and high) and a weighted sampling scheme was used to randomly select four counties in each province. In addition, the provincial capital and lower income cities were selected when feasible. Villages and townships within the counties and urban and suburban neighbourhoods within the cities were selected randomly. In 1989-1993 there were 190 primary sampling units, a new province and its sampling units were added in 1997. Currently there are about 3800 households in the overall survey, covering 16,000 individuals, including all age groups. The data can be stratified by region, gender and province. Follow-up levels are high, but families that migrate from one community to a new one are not followed.

The surveys collected information on all individuals living in the household. A complete household roster is used as a reference for subsequent blocks of questions on time allocation at home (e.g., child care, elderly care, other key home activities) and economic activities. Questions on income and time allocation probe for any possible activity each person might have engaged in during the previous year, both in and out of the formal market. Three days worth of detailed household food consumption information is collected. In addition, individual dietary intake for three consecutive days is collected for every household member, irrespective of age or relationship to the household head. Adults and children received detailed physical examinations that included weight, height, arm and head circumference and so on. Limited clinical nutrition and physical functioning data was collected in 1993, 1997, 2000 and 2004. Apart from the household and individual questionnaires, information is also collected on community infrastructure (water, transport, electricity, communications, and so on), services (family planning, health facilities, retail outlets), population, prevailing wages, and related variables.

The Study selected adults aged 18-45 in the survey to combine the study population. 5072 adult aged 18-45 in 1989, 5710 in 1991, 5202 in 1993, 5048 in 1997, 5160 in 2000 and 4474 in 2004 .

Result

Trends in dietary intake

Historically, the Chinese diet has been mainly plant based. The fat intake of the Chinese population remained at a low level for a relatively long time[4-5]. However, since 1990's, there have been noticeable changes to the Chinese dietary pattern due to rapid economic development, adequate food supply and changes in consumption pattern. With the income increase, the consumption of animal food, particularly meats and eggs, increased dramatically whereas the consumption of cereals and tubers has decreased. In general, these changes have improved the quality of the Chinese diet, however, as will be demonstrated in the following section, there are also some alarming trends in the intake of energy from fat,

Table 1 Composition of subjects

Population Group		1989		1991		1993		1997		2000		2004	
		n	%	n	%	n	%	n	%	n	%	n	%
Sex	Male	2400	47.3	2692	47.1	2460	47.3	2464	48.8	2486	48.2	2160	48.3
	Female	2672	52.7	3018	52.9	2742	52.7	2584	51.2	2674	51.8	2314	51.7
	Total	5072	100.0	5710	100.0	5202	100.0	5048	100.0	5160	100.0	4474	100.0
Age	18－	1132	22.3	1429	25.0	1252	24.1	1047	20.7	905	17.5	626	14.0
	25－	1052	20.7	1159	20.3	906	17.4	916	18.1	817	15.8	648	14.5
	30－	1028	20.3	884	15.5	867	16.7	1014	20.1	964	18.7	893	20.0
	35－	1015	20.0	1150	20.1	1066	20.5	832	16.5	1177	22.8	1032	23.1
	40－45	845	16.7	1088	19.1	1111	21.4	1239	24.5	1297	25.1	1275	28.5
	Total	5072	100.0	5710	100.0	5202	100.0	5048	100.0	5160	100.0	4474	100.0
Community	Urban	806	15.9	851	14.9	671	12.9	717	14.2	630	12.3	599	13.4
	Suburb	779	15.4	934	16.4	897	17.2	1005	19.9	997	19.4	914	20.5
	Town	756	14.9	910	15.9	805	15.5	761	15.1	867	16.9	686	15.3
	Rural	2731	53.8	3015	52.8	2829	54.4	2565	50.8	2645	51.5	2272	50.8
	Total	5072	100.0	5710	100.0	5202	100.0	5048	100.0	5160	100.0	4474	100.0

Table 2. Trends in intake of food groups for adults by residence (g/day)

food	total						rural						urban					
	1989	1991	1993	1997	2000	2004	1989	1991	1993	1997	2000	2004	1989	1991	1993	1997	2000	2004
rice	348	337	320	297	274	280	362	338	335	312	290	295	316	336	284	262	237	243
wheat	190	196	199	181	152	167	193	196	211	193	154	173	183	194	169	153	146	152
Other cereals	53	35	32	28	20	16	86	37	39	34	22	18	15	29	12	12	14	13
Tubers	139	94	89	83	73	42	174	95	98	91	78	47	88	91	66	67	70	29
Legumes and products	23	21	20	19	19	50	23	21	21	19	19	43	22	21	19	19	19	68
Vegetables	296	278	284	280	267	359	314	302	303	292	277	377	242	238	234	239	262	313
Fresh fruit	14	9	12	10	12	29	14	8	11	6	8	25	14	12	16	20	22	38
pork	52	59	62	60	69	62	44	59	52	49	60	54	71	59	89	86	91	80
Other meats	5	5	7	9	9	15	4	5	6	6	6	11	7	6	12	16	15	25
paultry	7	7	9	12	14	15	4	7	6	10	12	13	12	7	14	17	19	19
Milk and products	2	4	3	3	6	12	1	2	1	1	2	6	5	5	7	9	17	25
Egg and products	11	14	15	24	26	26	9	13	12	20	23	23	16	15	22	33	32	33
Fish	24	21	22	28	26	30	22	21	20	25	25	28	27	22	28	35	30	35
Vegetable oil	32	22	22	31	30	33	30	22	21	30	30	32	37	22	26	34	30	36
Animal fat	18	13	10	10	12	6	19	14	11	10	12	7	15	12	9	9	12	4
Cakes	1	2	2	3	2	6	1	3	1	2	1	6	2	1	4	5	5	8
Sugar	8	5	5	6	6	5	8	5	4	6	6	5	8	4	7	8	6	4
Salt	19	16	14	13	13	10	21	16	14	13	13	10	23	16	13	14	14	9
Pastes and soy sause	26	14	12	16	15	9	22	13	12	17	15	10	32	16	13	14	14	8
Other foods	13	12	12	14	14	36	13	12	11	12	13	36	14	12	15	19	16	36

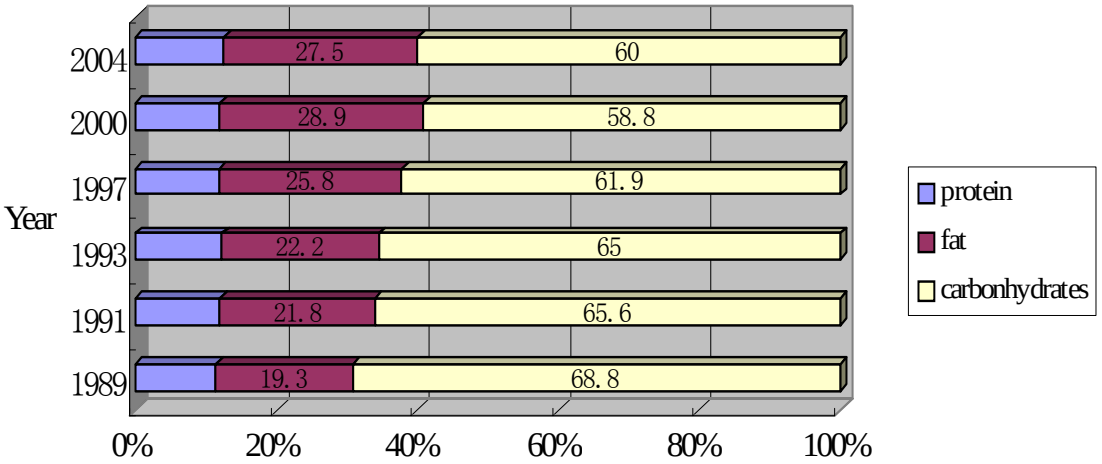

Figure 1. Trends in percent of macronutrients as proportion of total dietary energy intake

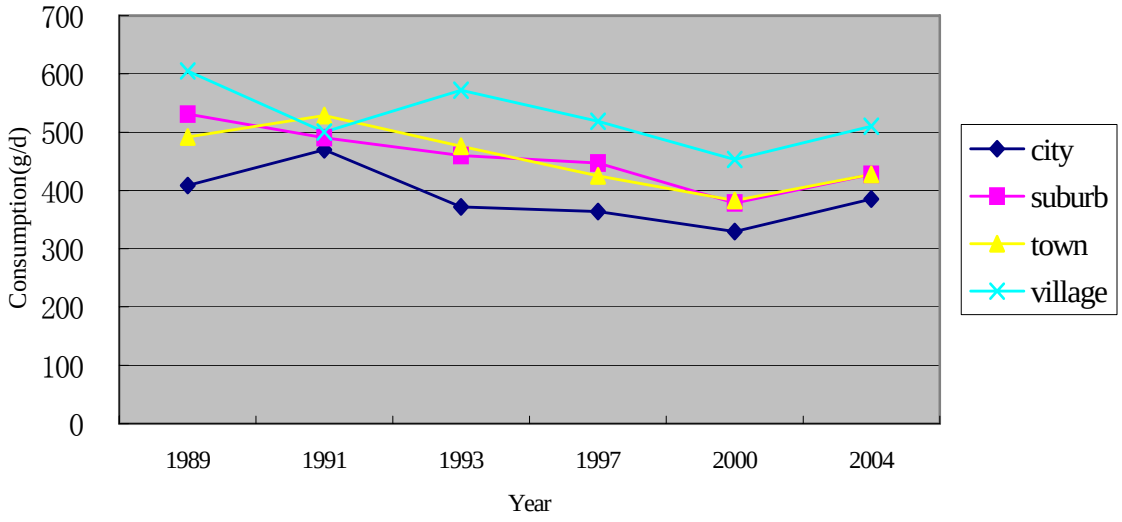

Figure 2. Trends in cereal consumption of adults (18-45 years) by residence, 1989-2004

increased consumption of saturated fat and cholesterol and decreasing consumption of fruits and vegetables. Many, but not all, of these changes are more pronounced in urban areas.[4-9]

Adult's intake of cereals and starchy roots has declined over the past ten years from 601g/d to 460g/d and 147g/d to 42g/d respectively. Intake of vegetables and fruits has remained relatively stable. During the same period the consumption of animal food, especially the consumption of meat and egg increased from 75g/d to 122g/d and 11g/d to 26g/d respectively (Table 2). Total energy intake has decreased, but the diet has become proportionately richer in fat and protein (Table 2). These trends generally represent positive developments in adult's diets. The proportion of dietary energy derived from fat in the adult diet has dramatically increased from 19 to 28 percent over the past decade, mainly due to replacement of calories from carbohydrate (Fig 1). The pace of this trend is alarming and signals a need to quickly attempt to slow intake of fats, as the population level of intake will soon be over recommended levels.

The changes of food groups, which accompany the trend in increasing fat intake, include an increased consumption of pork, milk and vegetable oils (Table 2). About one half of dietary fat comes from edible oil, while the consumption of refined animal fat decreased. Critical to controlling fat intake of the Chinese diet is decreasing consumption of vegetable oil, pork and pork products. The proportion of energy from fat reached 30 percent in the suburb and town areas and 35percent in urban areas. In 2004, urban adults' intake of cholesterol reached 376.8 mg/d. The intake of 54 percent of urban adults residents was over 300 mg/d. The intake of suburb and town residents increased to 318 mg/d and 285 mg/d respectively, but the intake of rural residents kept stable at a lower level of 150 mg/d. The high intake of dietary fat and cholesterol leads to the increase of risk of suffering from chronic diseases such as obesity, diabetes, cardio-vascular disease and some cancers, especially in middle age and elderly populations. Facing a rapid development of nutrition transition, it is important to better guide the public to make rational dietary choices and to take some measures to control high intake of dietary fat and cholesterol that are very significant factors in prevention and control of chronic diseases in China.

Analysis of trends in intake of major food groups stratified by income and urban/rural residence provides some interesting insight on current trends (Table 3). Certain trends in intake, for example increased intake of fruit, vegetables and milk seem to be dominated by residence, with urban consumers more likely to have increased intake of fruit and milk and rural consumers more likely to consume vegetables. Income can be seen as driving intake of sugar, while a combination of residence and income seems to appear in trends of meat consumption.

Figures 2 and 3 illustrate trends in consumption of cereals and meat products by residence. Since 1989, cereal consumption has decreased in all areas, with basically proportional decreases in all areas from 1993 to 2004. The pattern for consumption of meat has been somewhat different, rising dramatically from 1991 to 1993 first in cities and towns (county town) and then in suburban areas (suburban village) from 1997-2004. Meat consumption in the most rural village areas, has not increased as dramatically and is currently far below consumption levels in the three other areas. Intakes of dietary cholesterol

Comparing the survey from 1989 to 2004, the energy and protein intake was decreased. But the quantity of protein increased. The average calcium intake among the city and the suburb population was only about 430 milligrams per day, among the town and village population, the average calcium intake was about 380 milligrams per day. The intake of vitamins and other minerals was steady (Table 4).

Trends in Nutritional status

The status of nutrition among the Chinese people has been significantly improved and the quality of the average diet of the Chinese improved. Micronutrient deficiencies such as iron and vitamin A are still a problem in both

Table 3. Trends in food intake for adults (18-45 yrs) stratified by residence and income group (g/day)

food	total	rural			urban		
		low	medium	high	low	medium	high
Cereals							
1989	601	720	646	563	612	481	454
1991	568	665	572	490	652	546	485
1993	551	668	592	504	518	469	412
1997	506	592	545	487	460	423	403
2000	446	499	473	427	438	385	367
Tubers							
1989	147	262	158	107	147	66	56
1991	94	141	85	65	116	90	68
1993	89	129	97	73	75	66	56
1997	83	103	97	72	75	69	57
2000	73	92	78	65	67	54	54
Legumes							
1989	82	77	80	85	92	80	81
1991	83	69	92	87	67	92	90
1993	79	67	82	86	74	87	80
1997	84	76	81	87	88	97	80
2000	99	101	103	96	97	101	95
Meat							
1989	75	39	64	78	91	104	121
1991	85	41	87	118	50	92	117
1993	94	47	62	115	107	145	159
1997	105	56	75	119	110	171	166
2000	117	72	93	137	126	162	186
Fish							
1989	24	11	17	36	19	29	34
1991	21	9	17	34	13	16	36
1993	22	11	15	33	19	29	36
1997	28	16	24	34	21	33	49
2000	26	18	20	36	23	28	40
Milk							
1989	1.3	0.0	0.0	0.6	1.2	1.7	8.0
1991	2.0	0.3	0.1	3.8	0.1	1.4	8.0
1993	2.2	0.0	0.2	2.2	2.9	2.0	11.8
1997	1.8	0.1	0.5	0.9	0.9	3.8	9.3
2000	4.1	0.3	0.6	4.1	3.4	10.6	16.7
Vegetables							
1989	296	349	310	288	311	236	222
1991	278	292	288	269	285	261	261
1993	284	295	317	299	218	245	242
1997	281	281	306	289	242	254	264
2000	265	271	283	281	213	231	253
Fruit							
1989	14	4	10	27	4	15	22
1991	9	3	8	13	6	6	23
1993	12	4	8	20	6	11	31
1997	10	2	5	10	7	16	39
2000	12	4	6	14	11	20	36
Fats and oils							
1989	50	41	52	54	52	50	55
1991	35	29	35	42	32	32	39
1993	32	24	33	37	33	34	36
1997	41	34	40	45	40	45	42
2000	42	39	42	46	39	44	41
Sugar							
1989	2.7	1.5	1.6	3.8	2.1	3.1	5.4
1991	1.9	0.9	1.0	3.6	1.0	1.2	3.4
1993	2.1	1.1	1.0	2.4	2.7	2.4	5.4
1997	2.9	0.9	1.7	4.6	1.4	3.2	7.7
2000	2.3	1.2	1.5	3.7	1.0	2.1	5.2

Table 4. Nutrients intake by communities

community	year	N	Nutrients									
			Energy (MJ)	Protein (g)	Calcium (mg)	Iron (mg)	Zinc (mg)	Retinol (RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic Acid (mg)
city	1989	934	10.8	77.1	395.7	24.2	11.7	546.8	1.2	0.8	15.9	85.4
	1991	858	10.2	72.3	360.4	21.0	11.1	527.8	1.1	0.7	14.5	90.8
	1993	645	9.8	75.1	373.8	22.1	11.1	568.2	1.1	0.8	15.9	78.4
	1997	660	10.3	78.9	422.0	26.4	12.9	639.5	1.1	0.9	18.0	83.3
	2000	609	10.0	77.1	437.5	25.6	12.5	659.0	1.1	0.9	17.6	87.4
	2004	599	9.7	77.4	427.7	24.2	12.1	860.5	1.1	0.9	16.8	78.2
suburb	1989	988	12.5	84.6	458.7	25.8	13.2	730.8	1.4	0.9	17.3	135.7
	1991	944	10.5	72.2	353.7	21.2	11.2	496.2	1.2	0.7	14.6	99.7
	1993	877	11.0	80.0	420.5	23.2	12.4	559.7	1.2	0.8	16.4	106.4
	1997	919	11.2	77.5	464.5	28.4	13.3	624.8	1.1	0.9	18.3	101.7
	2000	882	10.4	75.6	431.8	25.5	12.6	608.8	1.1	0.9	18.0	96.0
	2004	917	9.9	72.1	430.0	23.9	12.2	786.1	1.1	0.9	16.2	82.0
town	1989	879	11.8	81.2	434.6	26.2	12.8	554.5	1.3	0.8	17.1	101.1
	1991	808	10.8	74.4	367.2	23.3	11.7	395.8	1.3	0.7	14.5	95.1
	1993	783	10.7	78.5	365.8	22.0	12.1	548.2	1.2	0.8	16.4	83.2
	1997	705	10.1	72.1	388.0	24.3	12.2	589.3	1.1	0.8	16.9	83.9
	2000	852	10.2	73.5	395.6	24.7	12.4	533.0	1.1	0.8	16.7	80.6
	2004	686	9.6	71.9	372.8	23.0	11.9	813.5	1.0	0.8	15.6	79.7
village	1989	2976	13.2	86.6	493.1	28.3	14.0	594.8	1.5	0.9	18.4	143.4
	1991	2877	10.5	74.2	365.9	22.5	11.4	410.4	1.2	0.7	14.8	88.2
	1993	2892	11.6	81.9	415.3	24.5	13.0	393.3	1.4	0.8	16.6	113.8
	1997	2595	11.0	74.3	396.9	25.8	12.7	391.0	1.3	0.8	17.1	92.4
	2000	2725	10.6	70.2	441.3	25.7	12.3	421.4	1.2	0.8	16.1	102.2
	2004	2272	10.2	73.2	396.4	23.8	12.1	661.6	1.1	0.7	15.7	98.5
total	1989	5777	12.5	83.9	462.5	26.9	13.3	604.3	1.4	0.9	17.6	126.3
	1991	5487	10.5	73.6	363.1	22.1	11.4	441.9	1.2	0.7	14.7	91.6
	1993	5197	11.2	80.2	403.1	23.6	12.5	468.6	1.3	0.8	16.5	103.2
	1997	4879	10.8	75.2	412.0	26.1	12.8	501.7	1.2	0.8	17.4	91.6
	2000	5068	10.4	72.5	431.5	25.5	12.4	501.3	1.1	0.8	16.7	95.7
	2004	4474	10.0	73.3	403.9	23.7	12.1	737.0	1.1	0.8	15.9	89.5

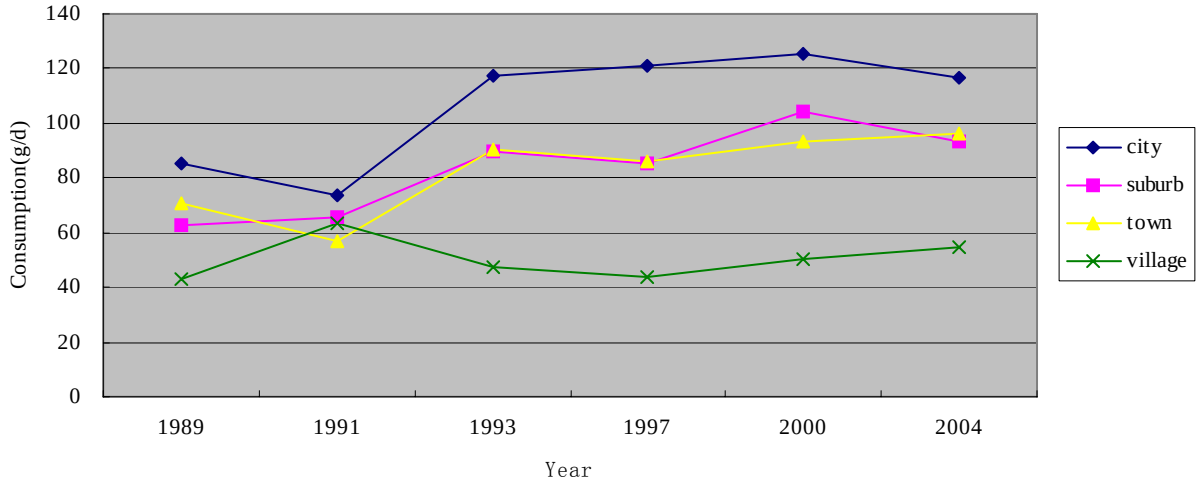

Figure 3. Trends in consumption of meat in adults (18-45 yrs) by residence, 1989-2004

urban and rural populations. Trends in the nutritional status of the Chinese population clearly demonstrate that under nutrition is reducing rapidly, while overweight and obesity are increasing in both children and adults.

Recent data from the China Economic, Population, Nutrition and Health Survey show that almost 19.9% of the adult population was overweight, which is defined as having a BMI greater than 25kg/m^2. While 6.8 percent of adults were underweight, which is defined as having a BMI less than 18.5 kg/m^2. In male the prevalence of overweight increased form 6.4 to 11.9 in 1989 to 2000. The percent of increasing was 210.9%. Moreover the rate of increasing was more rapid than before. In female the prevalence of overweight increased from 11.4 to 19.9 in 1989 to 2000. According to this information, in 2000 total numbers of overweight and obese persons are 200 million and over 60 million respectively in China (Fig 4).

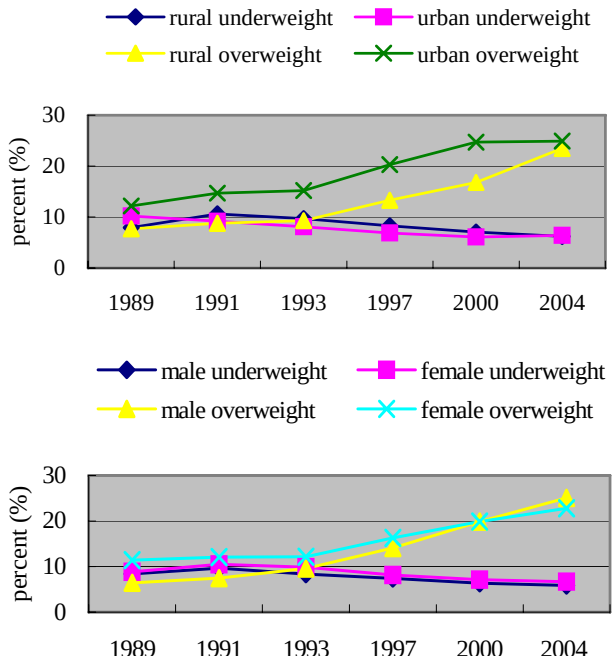

Figure 4. Trends in under and over nutrition in adults by urban and rural residence and gender

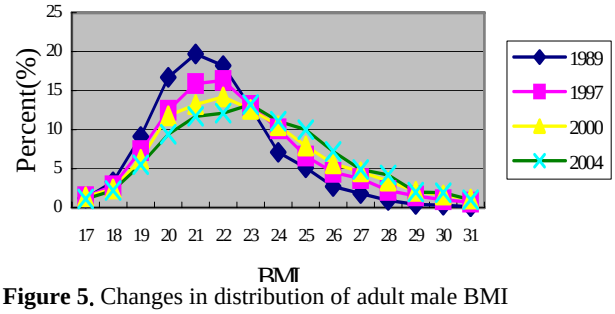

Figure 5. Changes in distribution of adult male BMI

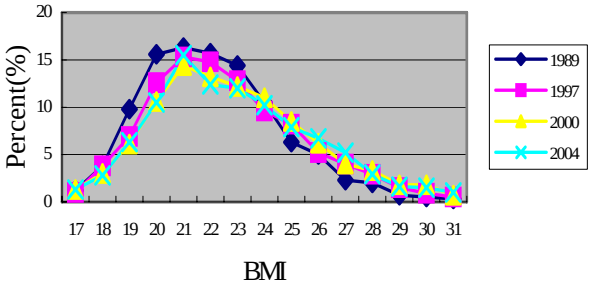

Figure 6. Changes in distribution of adult female BMI

The distribution of BMI estimated from this survey in 1989, 1997, 2000and 2004. are shown in Figure 5 and Figure 6. We can see the line of BMI moved to right both in male and female. So the proportion of right becomes bigger than before. If we do not act now the prevalence of overweight and obesity will increase more rapid than before.

Discussion

In the past twenty years, the status of diet and nutrition among the urban and rural Chinese population has been improved significantly, and the prevalence of malnutrition and nutrition deficiency has been continuously decreased.[1-4,10-13] Mortality from infectious disease, such as hepatitis, dysentery and malaria, had been controlled in the past twenty years. However, in the meantime China is undergoing a remarkably fast, but undesirable, shift towards a stage of the nutrition transition dominated by a high intake of fat and animal food, as well as a high prevalence of diet-related non-communicable diseases

such as obesity, diabetes mellitus, cardiovascular disease and cancer. At the same time, significant pockets of under-nutrition and poverty still affect millions of Chinese.

The status of nutrition and health among the Chinese people has been significantly improved in the past twenty years. China represents one of the more rapidly developing countries in the world. In the past two decades, the annual growth rate of the gross domestic product (GDP) was more than eight percent, the highest rate in recent world history. China has achieved remarkable economic progress and high levels of education, but a rapid evolution of the Chinese diet has accompanied these economic shifts and related social changes. A longer, more detailed history of the Chinese nutrition transition is available. The classic Chinese diet includes cereals and vegetables with few animal foods. It is a diet that many scholars consider most healthful when adequate levels of intake are achieved. With the prosperous economy, the quality of the average diet of the Chinese people has improved significantly. The energy and protein intake among the urban and rural population have been basically satisfactory, the consumption of meat, poultry, egg and other animal products has been increased significantly, and the percentage of good quality protein in the diet has increased. But the dietary pattern among the urban residents is not reasonable to certain extent. The consumption of meat and oil is too high, and cereals consumption is at a relatively low level. Low consumption of dairy and soy products remains a common problem in China. High dietary energy, high dietary fat and less physical activity are closely related to the occurrence of overweight, obesity, diabetes and abnormal blood lipid level; high salt intake is closed to the risks of hypertension. It should be particularly emphasized that those who had higher level of fat intake and less physical activity have the highest risks for the above mentioned chronic diseases.[13,14]

China is facing simultaneous challenges of under and over nutrition. The Governments efforts in the past decades, to reduce under nutrition have been very successful and the prevalence of stunted and underweight children has lowered significantly, although levels remain high in some poor rural provinces. The prevalence of growth retardation is highest among the one-year-old age group, and this demonstrates the significant problem associated with the improper use of complementary foods in infants in rural areas. Micronutrient deficiencies such as iron and vitamin A still exist in both urban and rural populations. On the other hand, The prevalence of overweight and obesity and the morbidity of non-communicable disease, such as hypertension, type 2 diabetes have been significantly increased in the past twenty years.[13,15] And the problem of abnormal blood lipid levels requires close attention. So the burden of the chronic non-communicable in China is becoming heavier in the past twenty years.

China is undergoing a remarkable, but undesirable, rapid transition towards a stage of the nutrition transition characterised by high rates of DR-NCDs in a very short time. Some public sector Chinese organisations have combined their efforts to create the initial stages of systematic attempts to reduce these problems. These efforts, which focus on both under- and over nutrition, include the new Dietary Guidelines for Chinese residents, the Chinese pagoda and the National Plan of Action for Nutrition in China, issued by the highest body of the government, the State Council. There are selected agricultural sector activities that are laudable and few other systematic efforts that are impacting behaviour. In the health sector, efforts related to reducing hypertension and diabetes are becoming more widespread, but there is limited work in the nutrition sector. One is need for the nutrition education activities to promote the principle of Dietary Guidelines for Chinese residents. Another is the need for strengthened guidance on increased physical activity and the dissemination of its benefit to the whole country.

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