

Body mass index of young Chinese adults

Keyou Ge

Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine, Beijing, China

Body mass index of young Chinese adults aged 20 to 45 years was assessed in relation to household income, energy and macronutrient consumption. The data were collected in the 1992 China National Nutrition Survey, with a sample of 8477 urban and 20911 rural subjects from provinces, autonomous regions and municipalities.

The mean values of BMI were 21.5 and 21.9 for urban males and females, and 21.1 and 21.5 for rural males and females, respectively. Inhabitants of the three Chinese municipalities (Beijing, Tianjin and Shanghai) presented a higher BMI value than the national averages.

Undernourished people (BMI<18.5) accounted for 9.0% in the urban and 8.0% in the rural populations, and the overweight (BMI≥25) sectors were 14.9% and 8.4% respectively.

In rural populations, the proportion undernourished is inversely related the average energy intake, and dietary fat intake is positively related to the proportion overweight. The change in recent years of BMI of Chinese adults is considered in relation to food consumption.

Key words: BMI (body mass index), China (Beijing, Tianjin and Shanghai) National Nutrition Survey of 1992, rural, urban, energy intake, fat intake, undernourished, overweight

Introduction

Anthropometric data of adults have been routinely collected in many surveys, but using these data to identify the undernourished groups has achieved limited results because of a lack of satisfactory indicators. Considerable efforts have been devoted to explore the nutritional significance of various weight/ height indices; body mass index (BMI) has become the focus of attention in recent years.

The report of a working party of the International Dietary Energy Consultative Group defined chronic energy deficiency (CED) using BMI for adults. It proposed 18.5 as the cut-off point for CED identification¹. Ferro-Luzzi *et al* examined three populations in Africa and Asia and determined that the use of BMI alone produced coherent data as BMI distributions changed, with only 5% of the population wrongly classified as being malnourished².

The optimum range of BMI was previously regarded as 18.7 to 23.8 for women and 20.1 to 25.0 for men³. Later, it was simplified to 20 to 25 as the acceptable range for both men and women in relation to body fatness⁴. A WHO study group, adopted cut off points of 18.5 for CED and 25 for obesity⁵. The BMI of Chinese adults has been considered in connection with CED only recently. A nationwide sample of 13,300 subjects aged 20-45 years surveyed in 1982⁶ determined that 12.3% of them were below 18.5 kg/m². A sample of 5162 subjects selected from 8 provinces in 1989 showed a decline of the undernourished proportion (8.47%), and even less in the high income group⁷.

A recent national nutrition survey was carried out in China in 1992. It collected a wide range of information at individual, household and community levels. The present paper is based on the 1992 survey data, and the discussion focussed on the distribution of BMI in young adults in connection with their dietary and economic conditions so that the role of BMI as an indicator for assessing nutritional status could be evaluated.

Method

The 1992 China national nutrition survey consisted of a dietary survey, anthropometry measurements, haemoglobin assay and some socio-economic information. The dietary survey covered 25,285 households (8608 urban and 16677 rural) and 99,954 household members of all ages. Body weight and height were taken in 82,538 individuals which accounted for about 82.5% of the sampled subjects.

Sampling

A multistage random cluster process was used to draw the sample. All provinces, autonomous regions and municipalities (Beijing, Tianjin and Shanghai) under the central government were covered in the sample frame. In each province/region/municipality 4-8 units (towns and counties) were selected by the criteria of population size and economic situation. In each selected town or county, two districts or townships were chosen, and in each district or township, two communities or villages were sampled as the primary survey sites. In each survey site, a cluster of 30 households were drawn as the survey subjects. In each of the 3 municipalities, 5 central districts and 3 suburbs were chosen at the first stage, the sub-stages process were the same as in the provinces. Therefore, the sampling design was framed as:

- 30 provinces, autonomous regions, municipalities
- 30 x 8 = 240 towns, counties
- 240 x 2 = 480 districts, townships
- 480 x 2 = 960 communities, villages
- 960 x 30 = 28,800 households

Correspondence address: Professor Keyou Ge, Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine, 29 Nan Wei Road, 100050 Beijing, China
Tel: +86-106-317-1734; Fax: +86-106-301-1875
Email: gky@public3.bta.net.cn

This sample design was reviewed by an expert committee, and recognised as reasonably representative of the whole population.

Dietary data collection

Two sets of questionnaires were designed, for the collection of household food consumption data and for individual food intake data. The household dietary data were collected by recording the inventory change from the beginning to the end of the 3 survey days, in combination with weighing food stuffs used as prepared for meals every day. Household members who participated in each meal were recorded. Household average per capita food consumption was calculated, and household average per reference person food consumption was also calculated taking into consideration age, sex and labour intensity of the household members. The individual intake data were obtained by 3 consecutive 24 hour recalls. Some food stuffs which were used for preparing dishes, such as cooking oil and salt, were assigned to the meal participants in proportion to their energy requirements. During the survey period, qualified interviewers visited the household every day, and the questionnaires (filled in by the interviewers) were reviewed by team leaders on the spot. The nutrient intakes were calculated based on the Chinese food composition tables⁸.

Anthropometry measurements

Body weight, height and upper arm circumference were measured by trained personnel with standardised scales and measures. A quality control process was in effect while the data collection was taking place in the field.

Socio-economic and community survey

The household income was reported by the head of the household. The economic categorisation of the households was based only on reported income, family assets were not taken into account. Community data were provided by community leaders and other knowledgeable individuals.

Result

The dietary and nutritional status were considered in relation to the household income tertile of a given population.

Nutrient intake

The national average intakes of energy, protein and fat are shown in Table 1. The overall consumption of energy was 2328 kcal per reference person per day. Urban inhabitants consumed about 100 kcal more than did rural people, on average. This difference mainly resulted from the greater consumption of the higher income groups. The low income inhabitants in both urban and rural areas consumed similar amounts of energy.

The protein consumption was 68g per day, on average, and increased in line with income in both urban and rural populations, but more obviously among urban groups. The high income group consumed 15g/day more protein than the poor, and urban people consumed 11g/day more than the rural.

Fat intake was most obviously associated with household income. High income groups consumed twice the amount of the low income groups. The fat intakes of urban

inhabitants in each of the three income categories were significantly higher than those of the rural.

Table 1. National average of nutrients intake by income levels (per reference person per day).

		Income Categories			
		Total	Low	Middle	High
Energy (kcal)	Urban	2395	2299	2384	2500
	Rural	2294	2292	2274	2315
	U+R	2328	2294	2285	2410
Protein (g)	Urban	75	65	76	84
	Rural	64	62	63	68
	U+R	68	62	65	77
Fat (g)	Urban	78	60	81	92
	Rural	48	38	46	61
	U+R	58	40	55	80

1992 China Nutrition Survey

Body mass index

In general, the BMI of adults is lower in the younger population and higher in the middle aged populations, but decreases again in the older groups. This is true for both males and females, and for both urban and rural inhabitants in this survey. The discussion here, however, will focus on the segment aged 20 to 45 years.

Mean value of BMI

The mean BMI values of the nationwide sample (except the three municipalities directly under the central government) is shown in Table 2. The males had lower BMIs than females. The differences between males and females are statistically significant ($P < 0.05$) for all the rural matchable pairs of groups, and for the urban overall and the low income groups. The mean BMI values of the high income category are significantly higher in comparison with the low income category in all listed populations except the urban females. Also, the overall means of the urban males and females are higher than the rural males and females respectively.

Table 2. Body mass index of Chinese adults in 1992, nationwide except the 3 cities of Beijing, Tianjin and Shanghai (subjects are 20-45 years).

Area	Income Categories							
	Low		Middle		High		All	
	N	Mean	N	Mean	N	Mean	N	Mean
Urban								
Male	1116	21.5 ^a	1362	22.4 ^d	1308	21.8 ^e	3786	21.9 ^{em}
Female	1493	21.9 ^b	1639	22.5 ^d	1559	22.0 ^{eb}	4691	22.2 ⁿ
Rural								
Male	3235	21.1 ^c	3164	21.3 ^e	3056	21.7 ^h	9455	21.4 ^p
Female	3927	21.5 ^a	3859	21.7 ^f	3670	21.9 ^e	11456	21.7 ^{fq}

Figures with the same letter are not statistically different.

The BMI means of the inhabitants of the three municipalities, Beijing, Tianjin and Shanghai, are shown in Table 3. The overall trends among the populations and income groups are similar to the nationwide results but somewhat less obvious, particularly in urban populations. The total urban males and the low income urban males were heavier than their rural corresponding groups ($p < 0.05$), but no significant difference was found between other comparable urban and rural pairs. It is interesting that the high income groups had a lower BMI value than the middle

income groups and the low income groups in all the given areas and sex groups except the rural males. The urban high income male group presented a significantly lower BMI than the middle income group.

The means of BMI of the three municipalities were apparently higher in comparison with the nationwide results in the matchable groups. The difference is about 1kg/m² on average, and also in most of the comparable pairs.

Table 3. Body mass index of Chinese adults in 1992, in the three cities – Beijing, Tianjin and Shanghai (subjects are 20–45 years).

Area Sex	Income Categories							
	Low		Middle		High		All	
	N	Mean	N	Mean	N	Mean	N	Mean
Urban Male	269	23.2 ^a	275	23.5 ^a	200	22.8 ^b	744	23.2 ^a
Female	346	23.3 ^a	304	23.2	221	22.7	871	23.1
Rural Male	170	22.6 ^b	207	23.0	168	22.9	545	22.8 ^b
Female	213	23.1	263	23.3	210	22.9	886	23.1

Figures with the same letter are not statistically different.

Distribution of BMI

The distribution of BMI amongst Chinese young adults is summarised in Table 4. The cut off points <18.5, 18.5 to 25 and >25 are adopted to classify chronic energy deficiency (CED), normal and overweight respectively. About 73 to 82% of the urban people and 78 to 88% of the rural people were in the normal range. More overweight people were seen in all female groups than in the matchable male groups. The middle income urban male group presented a smaller proportion of CED but a larger proportion of overweight than the low and high income groups. In urban females, the high income group showed a higher percentage of CED, but there were more overweight females in the middle income group. The rural populations showed a better centripetal distribution. Both the CED and overweight portions were smaller than that of the urban populations. Within the rural section, the low income male group and the middle income female group presented a higher percentage of CED than their comparable groups. The proportion of overweight increased with income in both male and female groups.

Table 4. Distribution of BMI of Chinese adults in 1992, nationwide except in the 3 Cities (subjects are 20–45 years).

Area Category	Income	BMI Distribution							
		<18.5		18.5–24.9		≥25–29.9		>30	
		N	%	N	%	N	%	N	%
Urban									
Male	Low	107	9.6	909	81.5 ^a	95	8.5 ^a	5	0.4
	Middle	111	8.1	1021	75.0 ^b	212	15.6 ^b	18	1.3
	High	132	10.0	1002	76.6 ^b	159	12.2 ^c	15	1.1
	All	350	9.3	2932	77.4	466	12.3	38	1.0
Female	Low	121	8.0 ^a	1189	79.6 ^a	169	11.3 ^a	14	0.9
	Middle	123	7.4 ^a	1197	73.0 ^b	281	17.1 ^b	38	2.3
	High	168	10.8 ^b	1135	72.8 ^c	227	14.6 ^c	29	1.9
	All	412	8.8	3521	75.1	677	14.4	81	1.7
Rural									
Male	Low	266	8.3 ^a	2842	87.9 ^a	113	3.5 ^a	14	0.4
	Middle	229	6.3 ^b	2781	87.9 ^b	136	4.3 ^a	18	0.6
	High	201	6.5 ^b	2585	84.6 ^c	251	8.2 ^b	19	0.6
	All	696	7.3	8208	86.8	500	5.3	51	0.5
Female	Low	323	8.2	3300	84.0 ^a	290	7.4 ^a	14	0.4
	Middle	355	9.3	3088	80.0 ^b	398	10.1 ^b	27	0.7
	High	305	8.3	2878	78.4 ^b	447	12.2 ^c	40	1.1
	All	983	8.5	9266	80.9	1126	9.8	81	0.7

Figures with the same letter are not statistically different.

Table 5. BMI of young adults of various areas, China 1992 (subjects are 20–45 years).

	Distribution (%)									
	Mean(kg/m ²)			<18.5		18.5–24.9		≥25		
	urban	rural	all	urban	rural	urban	rural	urban	rural	urban
Beijing	23.7	23.9	23.8	4.2	2.9	62.9	60.3	32.8	36.8	
Tianjin	23.1	22.9	23.0	5.0	3.7	68.4	79.1	26.5	17.2	
Hebei	23.5	22.1	22.6	4.4	4.5	66.7	82.5	29.0	13.1	
Shanxi	22.5	22.4	22.4	3.3	3.8	80.2	82.3	16.4	13.9	
Neimeng	23.5	22.3	22.9	3.3	4.3	70.7	85.6	26.0	10.2	
Jilin	22.6	22.4	22.5	5.4	4.9	76.0	80.4	18.6	14.8	
Heilongjiang	23.0	22.0	22.3	6.6	7.0	68.3	80.6	25.1	12.4	
Shanghai	22.3	21.8	22.0	10.4	10.0	72.5	78.3	17.2	11.6	
Jiangsu	22.4	22.6	22.5	6.4	3.8	74.6	79.6	19.1	16.6	
Zhejiang	21.9	21.6	21.7	8.5	8.8	78.3	82.2	13.2	9.0	
Anqing	22.7	21.9	22.1	4.5	3.8	74.1	87.3	21.3	8.8	
Fujian	21.6	20.7	20.9	11.8	13.8	78.7	81.8	9.6	4.6	
Jiangxi	20.9	20.6	20.6	15.4	13.5	80.8	84.3	3.8	2.2	
Shandong	22.6	22.1	22.2	5.7	4.4	76.7	83.6	17.6	12.0	
Henan	22.4	22.0	22.2	8.0	6.2	72.6	82.5	19.4	11.3	
Hubei	21.8	21.1	21.3	10.9	10.4	75.6	84.0	13.5	5.7	
Hunan	21.3	21.6	21.5	13.4	7.2	79.2	86.4	7.4	6.4	
Guangdong	21.8	21.1	21.5	10.1	12.0	74.6	80.9	14.4	7.0	
Guangxi	21.1	20.6	20.7	15.9	13.8	76.2	83.6	7.9	2.6	
Hainan	21.2	20.1	20.4	16.9	22.1	72.8	75.2	10.3	2.6	
Sichuan	21.0	21.5	21.3	14.1	6.0	80.8	88.3	5.1	5.6	
Guizhou	21.5	21.3	21.3	12.2	10.1	76.0	82.8	11.9	7.2	
Yunnan	21.8	20.9	21.2	8.5	9.3	79.6	86.4	11.8	3.9	
Xizang			21.4							
Shaanxi	21.5	21.3	21.3	9.0	9.4	82.2	84.5	8.9	6.2	
Gansu	21.9	21.7	21.7	10.9	6.4	77.2	86.1	11.8	7.5	
Qinghai	21.4	21.3	21.3	12.5	8.8	77.5	86.2	9.9	5.3	
Ningxia	22.5	21.8	21.9	4.6	4.7	81.4	86.5	14.1	8.7	
Xinjiang	22.6	22.1	22.2	7.3	6.6	72.3	79.9	20.4	13.5	

Correlation of BMI with nutrients intakes

The means and distribution of BMI by province, autonomous region or municipality are listed in Table 5. The means range from 20.9 to 23.7 for urban, and from 20.1 to 23.9 for rural populations. The underweight subjects (BMI<18.5) accounted for 3.3% to 16.9% of the urban and 2.9% to 22.1% of the rural populations. The overweight proportions were 3.8% to 32.8% of the urban people and 2.2% to 36.8% of the rural people.

Table 6 shows the average energy and protein intakes as percentages of the Chinese RDA⁹, and the energy from fat and from animal food as a percentage of the dietary total energy. The correlations between dietary and BMI variables were analysed. The coefficient and probability values are listed in Table 7. Based on this analysis, the mean values of BMI were not correlated with the dietary factors in discussion. The energy intake is inversely correlated with BMI in the undernourished population, and the percentage of energy from animal food is positively related to BMI in the underweight population, and inversely related to BMI in the acceptably nourished rural sector. Fat intake is negatively related to BMI in the acceptably nourished population in both urban and rural populations, and shows a positive correlation with the overweight in rural populations.

Discussion

Body mass index as an indicator for assessing the nutritional status of adults has attracted increasing attention, and data from a wide range of ethnic groups worldwide advocate the significance of BMI as a nutritional indicator for epidemiological studies and for comparison purposes. Data from developing countries have been highlighted

recently^{10,11}. The 1992 China Nutrition Survey provided nationally representative data on BMI of Chinese adults of various areas, sex and income levels. The BMI means of the urban people are higher than the rural, and the well being group is higher than the poor. The average energy and macronutrient intakes agree with the BMI data. The average intake of energy, protein and fat as shown in Table 1 are varied in association with the varying BMI of the urban and rural populations. Therefore, the mean BMI may reflect the general well being and food satisfaction rate of people in a given section of population. This relationship is better demonstrated among the rural inhabitants in the 1992 survey.

Table 6. Dietary intake of nutrients of young adults, China 1992 (subjects of 20-45 years).

	% of RDA				% of total dietary energy			
	Energy		Protein		Animal food		Fat	
	urban	rural	urban	rural	urban	rural	urban	rural
Beijing	96	95	108	93	20	12	31	26
Tianjin	97	85	108	85	18	4	30	18
Hebei	88	91	93	91	11	4	27	16
Shanxi	84	90	85	87	5	3	16	16
Neimeng	91	85	88	80	12	4	26	18
Jilin	95	95	91	83	8	5	22	18
Heilongjiang	95	81	95	68	14	4	29	23
Shanghai	93	90	115	99	23	13	31	21
Jiangsu	94	100	107	99	21	11	33	23
Zhejiang	92	93	124	103	25	10	28	20
Anhui	93	109	103	103	10	4	20	11
Fujian	87	82	109	84	19	10	26	12
Jiangxi	118	104	156	110	19	7	30	12
Shandong	95	91	116	96	17	5	27	19
Henan	88	94	96	91	14	7	26	13
Hubei	94	98	108	89	16	6	29	23
Hunan	90	102	89	91	12	7	25	11
Guangdong	110	91	157	110	30	20	33	27
Guangxi	87	84	120	77	24	10	28	19
Hainan	85	71	116	75	23	12	26	16
Sichuan	92	94	86	75	15	7	26	17
Guizhou	93	90	93	81	16	8	12	21
Yunnan	92	84	87	74	15	7	26	17
Xizang	129	-	97	-	9	-	38	-
Shaanxi	87	86	83	81	90	2	25	16
Gansu	96	87	93	88	8	2	20	10
Qinghai	88	96	91	96	12	4	26	17
Ningxia	86	93	86	87	8	3	19	15
Xinjiang	95	103	99	101	14	4	29	20

Table 7. Correlation coefficients between dietary and BMI variables, 1992.

		r	Dietary energy	Dietary protein	Energy from animal food	Energy from fat
			(% of RDA)	(% of RDA)	(% of total)	(% of total)
Urban						
BMI (Mean)	r	-0.082	-0.243	-0.242	0.093	
	p	0.679	0.214	0.214	0.638	
BMI<18.5	r	0.124	0.341	0.413	0.091	
	p	0.529	0.076	0.029	0.646	
BMI18.5-24.9	r	-0.059	-0.065	-0.211	-0.378	
	p	0.767	0.744	0.281	0.047	
BMI≥25	r	-0.042	-0.158	-0.099	0.189	
	p	0.830	0.422	0.614	0.336	
Rural						
BMI (Mean)	r	0.282	0.128	-0.211	0.289	
	p	0.145	0.518	0.282	0.136	
BMI<18.5	r	-0.449	-0.116	0.473	-0.044	
	p	0.017	0.557	0.011	0.823	
BMI18.5-24.9	r	0.152	-0.077	-0.444	-0.534	
	p	0.439	0.699	0.018	0.003	
BMI≥25	r	0.169	0.135	0.040	0.443	
	p	0.391	0.495	0.840	0.018	

Considering the findings from the China 1982 Nationwide Nutrition Survey¹² and the 1989 China Health and Nutrition Survey², a trend towards decreasing underweightness and increasing overweightness was observed among comparable populations as shown in Table 8. Food consumption data published by the China Statistical Bureau indicates a steady increase of per capita consumption of meat, edible oil, sugar, eggs, milk and fish during this period of time¹³. The consumption of these foods is positively associated with overweight and negatively associated with BMI in the underweight adult populations.

The analysis of individual province data resulted in no significant correlation of energy consumption with the means or distribution of BMI in most groups. It found that in rural populations, the undernourished portion declined while the achieved satisfactory rate for energy consumption increased. Over consumption of energy is generally believed to be an important contributor to obesity in adults. Some studies, however, revealed 300-400 kcal less energy was consumed by obese people than by healthy weight people¹⁴. Energy consumption is closely related to physical activity of individuals. Obese people tend to be less active and have a lower basal metabolic rate (BMR). It seems imprudent to make any conclusion in this regard without careful observation of the energy expenditure of subjects. Popkin *et al* pointed out that the prevalence of obesity was related to the total fat and animal fat intake¹⁵. The 1992 survey showed that the percentage of dietary energy obtained from fat positively correlated with overweight ($p=0.018$), and negatively correlated with the proportion of undernourished subjects ($p=0.003$) in rural populations.

Table 8. Comparison of BMI distributions of Chinese young adults of different surveys (subjects are aged 20-45 years).

Area	Year	N	BMI in these categories (%)		
			<18.5	18.5-24.9	≥25
Urban	1982	5510	11.6	78.7	9.7
	1989	1606	10.1	77.9	12.0
	1992	8477	9.0	76.1	14.9
Rural	1982	7814	12.9	81.0	6.0
	1989	3556	7.7	84.8	7.5
	1992	20911	8.0	83.6	8.4

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The data analysis was carried out in the Carolina Population Center, North Carolina University at Chapel Hill. Dr Barry Popkin provided valuable advice and support for this work.

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Keyou Ge

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中国青壮年的体质指数

葛可佑

中国预防医学院营养与食品卫生研究所

利用1992年中国营养调查的材料,对全国29388名(城市8477名、农村20911名)20-45岁被调查者的体质指数(BMI)结合其家庭收入,能量及蛋白质、脂肪摄入情况进行了分析。

城市男性的平均BMI为21.5,女性为21.9。农村男女分别为21.1和21.5。三个直辖市居民平均BMI高于全国均值。营养不良者(BMI<18.5)在城市人口中占9.0%,在农村人口中占8.0%。超体重者(BMI≥25)在城市及农村人口中分别为14.9%和8.4%。

在农村人口,营养不良发生率与平均能量摄入呈负相关,超体重发生率与脂肪摄入量呈正相关。对近年来中国成人体质指数的变化趋势与食物消费状况进行了讨论。

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