Original Article

Nutrition of elderly people in China

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Cross-sectional data from the 1991 (n = 1657) and 1993 (n = 1773) China Health and Nutrition Surveys were used to describe patterns in the diets, activity levels and body mass index (BMI) of elderly Chinese (aged 60 or older). In 1991 and 1993, the prevalence of low BMI (BMI < 18.5 or BMI < 22.0) exceeded 15%, while the prevalence of high BMI (BMI > 25.0 or BMI > 27.0) ranged between 4% and 24%. The BMI was consistently, positively and significantly associated with urban residence. Urban residence and income were consistently and positively associated with energy from fat and protein intakes, and decreasing physical activity levels. The results suggest that under- and overnutrition coexist among Chinese elders and are differentially distributed across income and urban/rural strata.

Key words: body mass index, elderly Chinese, nutrition.

Introduction

China has witnessed extremely rapid economic growth over the past two decades. Since reforms began in 1978, China's gross national product and gross domestic product increased remarkably by over 8.2% annually.[1] China's fast growing economy places it as a major trade partner in the world and a leader in economic development among low-income countries.[2]

Equally dramatic changes in the diets, activity and body composition of the Chinese population occurred during the 1980s and 1990s. Economic reforms and open policies increased the production of major foods, eliminated food scarcity at the national level and stimulated a shift in food consumption patterns.[3,4] Data on Chinese national food consumption demonstrate a 50% decline in the intake of grains and potatoes and a quadrupled intake of meat, eggs, milk and aquatic products since 1982.[4] Between 1982 and 1989, per capita rural energy intakes increased approximately 150 kcal, while protein and fat intakes increased 4 g and 8 g, respectively.[5]

Physical activity patterns have changed dramatically in China with shifts in occupation, transportation, labour-saving devices in the home and leisure activities.[6–8] These shifts have been linked with reduced energy expenditure and reduced energy intake in adults.[6,7]

Among adult Chinese, weight status has shifted in parallel with the greater food availability and changing activity patterns. General trends towards a reduced overall prevalence of underweight have been reported for Chinese adults, aged 20–45.[5,6,9] Between 1982 and 1989, the proportion of Chinese adults aged 20–44 who were overweight (body mass index (BMI) > 25.0) increased 4.8% for the urban sample and 2% for the rural sample.[5] Development-related increases in protein and fat intake and decreases in physical activity and energy requirements have been associated with an increasing prevalence of overweight and obesity among adults worldwide.[8,10]

In many low-income countries, extremely rapid transitions in development and diet create a bipolarized situation where problems of poverty and excess exist side by side.[11,12] Inequality between income groups and region is manifested by undernutrition among the poor and rural residents and overnutrition among the rich and urban residents. Urban residents characteristically have more sedentary lifestyles, lower activity levels and consume lower total energy intakes, but proportionately more energy from fat and protein. Given the lower activity levels and increased energy from fat and protein, urban residents tend to have a higher BMI than rural residents. Initially, income tends to be strongly and positively associated with energy, BMI, as well as fat and protein intakes. Popkin *et al.* noted this situation among Chinese adults (aged 20–45) in several panels of the Chinese Health and Nutrition Survey.[3,7,9] Between 1989 and 1991, the proportion of underweight people declined for middle- and high-income urban men and women, but increased for rural men and low-income men and women.[9] With continued development and urbanization, evidence suggests a weakening effect of income on total energy intake as energy requirements decrease.[13]

The effects of recent changes on the diets, activity levels and weight status of nationally representative samples of Chinese elderly have not been reported or evaluated. We hypothesized that the bipolarized patterns observed among younger adults also apply to the Chinese elderly. Information about the nutritional status of the Chinese elderly is needed to confirm or refute this hypothesis and inform plans for the

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future. Given current demographic projections and the epidemiologic transition already underway in China, the hypothesized patterns may hold tremendous implications for China's health care and support systems. China already has the largest elderly population in the world.[14] Current projections suggest that the Chinese elderly population aged 65 and above will increase two- to threefold over the next 30 years, to more than 330 million by the year 2050.[15,16] In the economically developed cities, diseases linked to diets high in animal products and fat and sedentary lifestyles (including cardiovascular disease, cancer, osteoporosis and diabetes) have already become the main causes of death, accounting for an estimated 63% of the potential life span in 1991 and expenses up to 56 million yuan/year.[17]

As a first step towards understanding the effects of urbanization and development on the nutritional status of elderly Chinese, this paper aims to systematically describe the food and nutrient intake patterns, activity levels and prevalence of under- and overweight in two large cross-sectional samples of Chinese over age 60. More specifically, the paper describes cross-sectional variation in the weight status, activity levels, consumption of selected food groups, energy, fat (as a proportion of total energy) and protein (as a proportion of total energy) intakes of elderly Chinese in 1991 and 1993 by age, gender, income and urban/rural residence.

Methods

The 1991 and 1993 panels of the China Health and Nutrition Surveys (CHNS) were used for this analysis. The China Health and Nutrition Surveys cover eight provinces that vary substantially in geography, economic development, public resources and health indicators (Guanqxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Liaoning and Shandong). A multistage, random cluster process was used to draw the sample surveyed in each of the provinces. Counties in the eight provinces were stratified by income (low, middle, high) and a weighted sampling scheme was used to randomly select four counties in each province (one low income, two middle-income, one high income). Within each county, the town where the county government is located was selected and three villages were chosen randomly. In addition, each provincial capital and a lower-income city from each province were selected. Within each city, urban and suburban neighborhoods were selected randomly. The sample design consisted of 188 primary sampling units, including 3870 households and covering about 16 000 individuals. Except for a part of the Guanqxi and Guizhou province samples, all persons studied had a Han background (85%). The China Health and Nutrition Survey follows human subjects approval procedures that have been approved both by the University of North Carolina School of Public Health and Chinese Academy of Preventive Medicine human subjects protection committees.

Dietary data

Detailed household- and individual-level food consumption data were collected for 3 consecutive days. An attempt was made to initiate dietary data collection on different days for different households in each secondary sampling unit. The supervisor checked the diet data for discrepancies between the household- and individual-level information. Further questioning was carried out if discrepancies were identified.

Household food consumption was determined on a daily basis by calculating changes in food inventory. Chinese scales with a minimum and maximum limit of 20 g and 15 kg, respectively, were used. All foods in stock at the initiation of the survey (including edible oils, sugar and salt), foods purchased and/or produced at home during the survey period and food preparation waste (including spoiled rice or food fed to animals) were weighed and considered in the calculation of household food consumption.

Individual-level dietary intake data for all household members for each of the 3 survey days were obtained via a 24-h diet recall interview. Composite dishes were recorded in terms of their raw ingredients. Individual consumption of fat and seasonings added during cooking were estimated from the household-level oil and condiment data. These estimates reflected each individual's proportion of the total household meat and vegetables consumed age, sex and physical activity level. The 1991 Food Composition Table for China was used to calculate the mean energy and nutrient intakes from the dietary data.[18]

To give an overview of food consumption patterns, four food groups; rice and products, high-fat red meats, eggs and plant oils, were chosen to represent the main staple, fat and protein sources in China. Mean daily intakes of these four food groups were calculated from the CHNS food-level data using the University of North Carolina at Chapel Hill–Institute of Nutrition of Food Hygeine (UNC-CH-INFH) China Food Grouping system. This food grouping system was designed to capture nutritionally meaningful differences in nutrient composition (for example, fat, protein and carbohydrate). High-fat red meats were defined as having greater than 10 g of fat per 100 g of meat (edible part), equivalent to more than 40% energy from fat. The rice and products food group used in this analysis excludes foods with greater than 15 g of fat per 100 g and thus does not include fried rice products, cakes, cookies or pastries.

Physical activity data

In addition to the dietary data, physical activity was recorded as a multilevel variable (very light, light, moderate, heavy). The level of physical activity was determined based on regular daily occupations. Very light activity was characterized by working in a sitting position or as an office worker; light activity as work in a standing position; moderate activity as work carried out by drivers or electricians and heavy activity as the work of farmers. This activity variable was designed by the Chinese Nutrition Society to reflect total energy expenditure, and intended for use in calculating the Chinese recomended daily allowances (RDA). The variable significantly predicts energy intake and weight status among Chinese adults,[6] as well as in this sample of Chinese elderly (results not shown).

Anthropometric data

All field workers were nutritionists with special training in dietary data collection and anthropometric measurement techniques. Weight and height measurements were obtained from all participants by two health workers. Bodyweight was measured in light indoor clothing with a beam balance scale

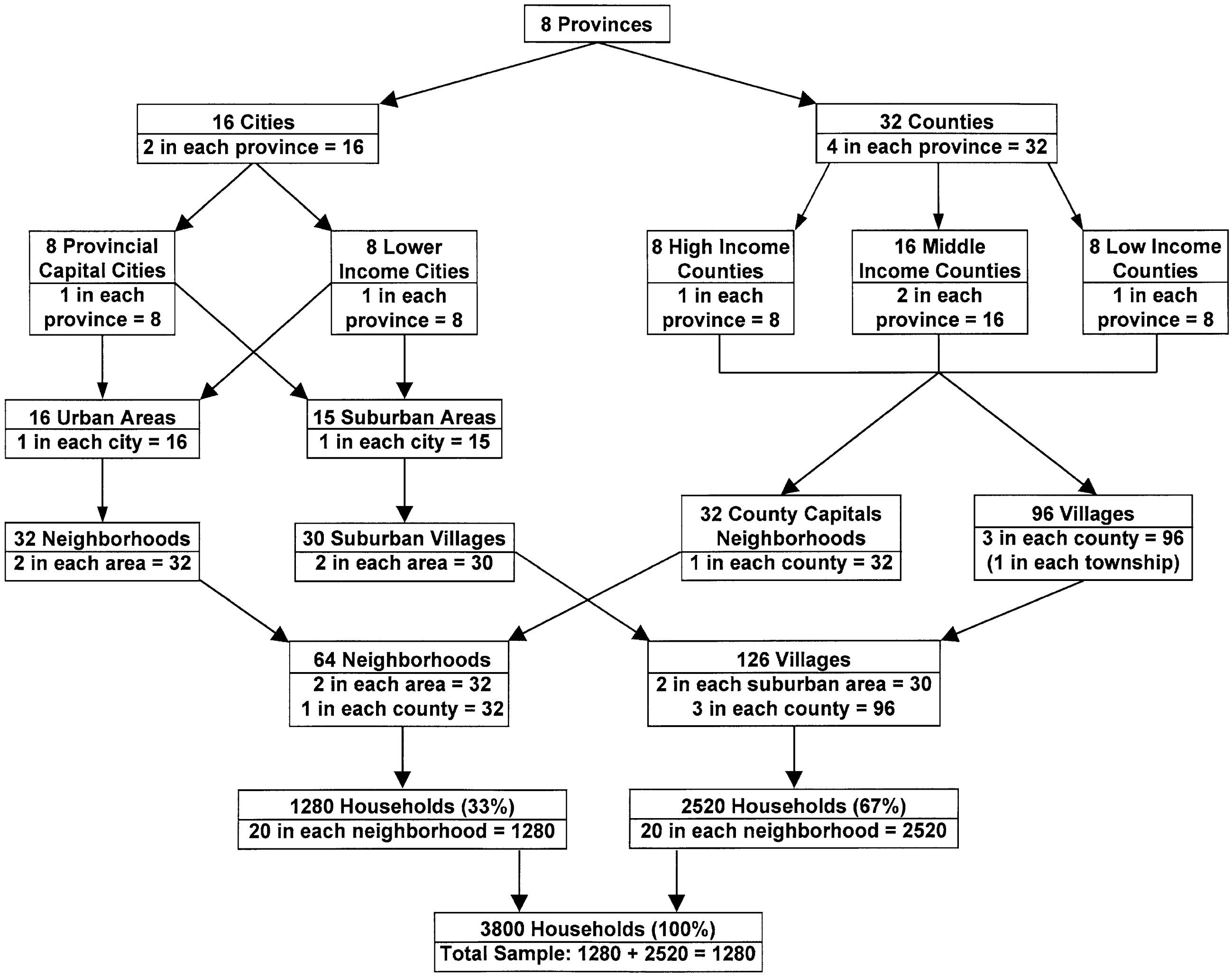

Figure 1. Sampling procedure for the Chinese Health and Nutrition Surveys.

to the nearest tenth of a kg. Height was measured without shoes to the nearest mm, using a portable stadiometer.

The BMI was calculated as weight (kg)/height (m^2). The continuous BMI variable was categorized into low, middle and high categories, as underweight and overweight status confer risk of different public health problems. Although a U-shaped relationship between BMI and mortality has been reported for several elderly populations, there is no consensus as to the most favourable range of weights.[19,20] In Norway, the nadir of the mortality curve was at 21–27 and 23–27 for men and women, respectively.[21] For a sample of elderly Finnish men, the lowest mortality was associated with a BMI of 27–31.[22] Although risk-based reference points are unavailable for the elderly Chinese, evidence suggests that lower cut-offs may be more appropriate for this population group. Elderly individuals of Chinese descent are known to have considerably lower BMI than elderly individuals from Brazil, Northern Europe and the USA.[20] The mean BMI reported in a study of non-diseased, non-cognitively impaired Chinese men and women, aged 70–90 years, ranged from 20.1 to 22.3.[23] For the present analysis, the BMI variable was categorized relative to two sets of criteria, 18.5–25.0 and 22.0–27.0. The former cut-off points may represent normal weight status for adults up to age 70, according to WHO standards.[20] The latter cut-off points, though not based on any universally recognized standard, are felt by most authorities to be more appropriate cut-off points for normal BMI among the elderly.[24]

Sociodemographic data

Questions on income asked for any income-producing activity each person might have engaged in during the previous year. Income from market and non-market activities and non-monetary government subsidies (food subsidies in the form of ration coupons) were included in the income estimate. Per capita income was deflated by the relative Retail Price Index which was 100 at base year of 1985.[25] All households were categorized as top, middle or bottom income tertile based on income per capita in cross-sectional analysis. Age information was collected under both Chinese and Western calendars and transferred to the Western calendar. Urban and rural areas were defined according to the Chinese census definition, which considers small towns and city neighborhoods as urban, villages and suburbs as rural.

Missing data

Due to the household-level interviewing, complete information was available on the age, sex, province, urban/rural residence and household characteristics of all individuals aged 60 and over in the 1991 ($n = 1657$) and 1993 ($n = 1773$) CHNS surveys. Even if an elderly person did not participate in the survey, questions addressed to other members of the household assured the availability of this information. Low response rates, loss of follow-up and missing data are common problems for studies of the elderly, which limit the external validity of results. For the 1991 and 1993 surveys, respondents in selected provinces were expected to come to central clinics for collection of physical examination data. This requirement resulted in a much higher non-response rate among the older sample. In both the 1991 and 1993 samples, individual-level anthropometric, activity and/or dietary intake data were missing for 15–20% of the sample. With the complete household-level data, however, it was possible to characterize the subjects with missing data. Table 1 presents results from probit models with availability of diet or BMI as outcome variables and age, sex, income, urban/rural status, household size, province, and type of roads (dirt, gravel or paved) as independent variables. Information on level of physical activity was collected during the dietary interview and is therefore missing only when/if the dietary data is missing. The groups missing height, weight and/or dietary information in 1991 were significantly older, from larger families and less likely to live in the Jiangsu Province than the whole sample. Residents of Henan Province were significantly more likely to have missing BMI data, while residents of Guanqxi Province were more likely to have missing dietary information in 1991. For the 1993 sample, those missing both types of information were significantly older, from larger families, more rural and more likely to belong to the top income tertile. Residence in Henan Province was predictive of missing anthropometric data in 1993. Characteristics of the 1991 ($n = 1397$) and 1993 ($n = 1424$) sample populations with either diet or anthropometric data are shown in Table 2.

The 1993 sample was slightly larger and included different households from the 1991 sample. Individuals aged 58 in 1991 were included in the 1993 sample.

Analysis

Separate cross-sectional analyses of the 1991 and 1993 panel data were conducted to explore for consistent and generalizable patterns in the distribution of energy, fat and protein intakes, rice, high-fat red meat, eggs and plant oil consumption, activity levels, as well as the prevalence and distribution of weight status (BMI). Our specific aim was to examine each of these variables stratified by age group, sex, income tertile and urban/rural residence for each survey year.

To estimate stratum-specific food and nutrient intakes and mean BMI, adjusted for the other covariates, we fit ordinary least squares (OLS) regression models predicting each continuous outcome with age group, sex, income tertile and urban/rural residence as independent variables. Due to the fact that dietary or anthropometric data were differentially missing for older individuals from larger households, we noted that the mean intakes and BMI estimated from this sample may not be externally valid. The energy intakes estimated from the (significantly younger) sample may be higher than the true values for the full sample, for example. Given that our purpose was to generalize our findings to the eight provinces covered by the China Health and Nutrition Surveys, it was necessary to test and adjust for this potential selection bias. We adapted each OLS model into a Heckman–Singer model that takes advantage of complete data for the full sample to adjust estimates for missing observations and test for selection bias.[26] The Heckman–Singer model

Table 1. Results of probit models with availability of dietary or anthropometric data (missing = 1, observed = 0) as outcome variable and age, sex, income, household size, urban residence, province and local road characteristics as independent variables

	1991		1993	
	BMI β(SE)	Diet β(SE)	BMI β(SE)	Diet β(SE)
Age 65–69 years (yes/no)	0.2 (0.1)*	0.3 (0.1)*	0.2 (0.1)*	0.2 (0.1)
Age 70–74 years (yes/no)	0.3 (0.1)*	0.5 (0.1)*	0.5 (0.1)*	0.4 (0.1)*
Age 75+ years (yes/no)	0.7 (0.1)*	0.7 (0.1)*	0.8 (0.1)*	0.8 (0.1)*
Female gender (yes/no)	0.0 (0.1)	0.1 (0.1)	0.1 (0.1)	0.0 (0.1)
Urban residence (yes/no)	–0.1 (0.1)	–0.2 (0.1)	–0.2 (0.1)*	–0.2 (0.1)*
Low income (yes/no)	–0.1 (0.1)	–0.1 (0.1)	–0.2 (0.1)*	–0.1 (0.1)
Medium income (yes/no)	0.0 (0.1)	0.1 (0.1)	–0.2 (0.1)*	–0.2 (0.1)
Liaoning Province	–0.0 (0.2)	–0.2 (0.2)	–0.2 (0.2)	–0.3 (0.2)
Jiangsu Province	–0.5 (0.2)*	–0.3 (0.2)*	–0.1 (0.1)	–0.1 (0.1)
Shandong Province	–0.1 (0.1)	–0.3 (0.1)	0.1 (0.1)	–0.0 (0.1)
Henan Province	0.3 (0.1)*	–0.1 (0.1)	0.3 (0.1)*	0.1 (0.1)
Hubei Province	0.1 (0.1)	0.1 (0.1)	0.2 (0.1)	
Hunan Province	–0.3 (0.2)	–0.0 (0.1)	0.1 (0.1)	0.2 (0.1)
Guanqxi Province	–0.1 (0.1)	–0.3 (0.1)*	–0.1 (0.1)	0.0 (0.1)
Road type 1 (yes/no)	0.2 (0.1)	0.0 (0.1)	–0.1 (0.1)	–0.3 (0.1)*
Road type 2 (yes/no)	0.2 (0.1)*	0.2 (0.1)	0.0 (0.1)	–0.0 (0.1)
Household size (No. persons)	0.1 (0.0)*	0.1 (0.0)*	0.1 (0.0)*	0.1 (0.0)*
Constant	–1.5 (0.2)	–1.7 (0.2)	–1.4 (0.2)	–1.5 (0.2)

β, the change in log likelihood of missing the information relative to the reference year 1991, age 60–64, male, rural residence, high income, Guizhou Province, paved roads, per individual in the household. *Statistically significant difference, ($P < 0.05$).

tests the hypothesis of no correlation (rho, $\rho = 0$) between error terms in two specified equations: the OLS regression equation of interest, and a probit equation that predicts whether the outcome of interest is observed or missing. The probit component of the Heckman–Singer models included age, sex, income, urban/rural status, household size, province and type of roads (dirt, gravel or paved) as independent variables.

In contrast to the continuous outcome variables, the categorical activity and weight status variables were evaluated using multinomial logistic regression models. The prevalences of low, middle and higher BMI, relative to both sets of cut-offs, were estimated as the proportion (%) of the sample in each weight category and treated as the dependent variables in models with age group, sex, income and urban/rural residence as the independent variables. Similarly, the proportions of the sample with very low, low, moderate and high activity levels were estimated. Since Heckman–Singer models cannot accommodate categorical outcomes, the prevalence estimates were not adjusted for selection bias.

After estimation of the Heckman–Singer or multinomial logistic models, the predict command available with the STATA[27] statistical program was used to predict adjusted stratum-specific means and prevalences. We then described and compared the adjusted effects of each sociodemographic variable on diet and weight status in each year.

Results

Patterns in dietary intake

The crude mean energy and nutrient intakes observed for men and women in 1991 and 1993 are shown in Table 2. Expressed as a proportion of the age-, sex- and physical activity-specific Chinese recommended dietary allowance (RDA),[18] the mean energy and protein intakes of the 1991 sample were 118% and 101% of the RDA (not indicated in Table 2). On average, the energy and protein intakes in 1993 were 112% and 98% of the RDA, respectively. In both survey years, approximately one-third of the sample population derived more than 30% of energy from fat, while approximately 22% of the sample derived less than 10% of energy from fat (also not indicated in Table 2).

To examine relationships between age, gender, income, urban/rural residence and dietary intake, Heckman–Singer models were used to predict stratum-specific mean intakes for each age, gender, income and urban/rural group for each cross-sectional sample (Table 3). Each stratum-specific mean was adjusted for the other covariates, as well as selection bias. Heckman–Singer models take advantage of complete data for the full sample to adjust regression coefficients (derived from the underlying OLS regression model) for missing observations.

Although age and sex appeared to have no significant effects on protein (as a percentage of energy) and fat (as a percentage of energy) intakes, males and the younger age groups had significantly higher energy intakes than females and the oldest age group in both 1991 and 1993. Urban/rural residence significantly influenced all of the dietary variables examined in both survey years. Urban residents consistently had significantly lower energy intakes, but significantly higher energy from fat and protein than their rural counterparts. In 1991, increasing income was significantly associated with greater energy, fat (as a percentage of energy) and protein (as a percentage of energy) intakes. Although fat and protein intakes remained significantly and positively related to income tertile, the association observed between income and energy intake in 1991 appeared weaker in 1993. The difference in energy intake between the middle and highest income tertiles disappeared.

With respect to consumption of rice, rice products, plant oil, high-fat red meats and eggs, several statistically significant and consistent associations were observed. In parallel with decreasing energy intake with age, rice consumption decreased with each older age group. Consumption of plant oil, high-fat red meat and eggs increased with income tertile, in parallel with positive associations between income and fat and protein intakes. Urban residence was associated with significantly lower rice consumption and higher intakes of high-fat red meat, consistent with lower energy intakes but higher protein and fat intakes among urban residents.

Table 2. Characteristics of elderly Chinese subjects (over 60) in the 1991 and 1993 China Health and Nutrition Surveys

	1991 (n = 1397)		1993 (n = 1424)	
	Men (n = 660)	Women (n = 737)	Men (n = 688)	Women (n = 736)
Mean (SD)				
Age (years)	67.4(6.2)	68.8(7.2)	67.4(6.3)	69.2(7.4)
Weight (kg)	57.2(10.9)	49.4(10.0)	57.5(10.2)	50.4(9.7)
Height (cm)	162.8(6.3)	150.5(6.3)	162.8(6.3)	151.2(6.7)
Body mass index (kg/m^2)	21.5(3.5)	21.8(3-9)	21.6(3.2)	22.0(3.7)
Energy (kcal)	2511.5 (670.4)	2110.5 (590.9)	2374.5 (636.8)	2046.4 (580.1)
Fat (as % of energy)	26.8 (11.2)	27.4(11.6)	27.1 (11.1)	27.2(11.2)
Protein (as % of energy)	11.7(2.4)	11.7(2.3)	11.9(2.5)	12.0(2.4)
Income (Yuan/year)	735.3 (602.1)	644.8 (481.3)	775.5 (737.8)	713.8 (649.6)
Frequency				
Urban	309(46.8)	340(46.1)	315(45.8)	336(45.7)
Rural	351 (53.2)	397(53.9)	373(54.2)	400(54.3)
Age 60–64 years (%)	278(42.1)	254(34.5)	279(40.6)	248(33.7)
Age 65–69 years (%)	171(25.9)	188(25.5)	202(29.4)	193(26.2)
Age 70–74 years (%)	108(16.4)	130(17.6)	100(14.5)	131(17.8)
Age 75+ years (%)	103(15.6)	165(22.4)	107(15.6)	164(22.3)

Patterns in physical activity

As might be expected, older age groups were significantly more likely to report very low activity levels and less likely to report medium or high activity levels in both survey years. Income was directly associated with very low activity patterns and inversely associated with higher levels of activity. Whereas over 40% of the higher income group reported very low activity, less than 30% of the lowest income group reported very low activity in both survey years. Urban residents also had significantly lower activity levels than rural residents. Almost 50% of urban elders reported very low activity levels, compared to an estimated 20% of rural elders.

Patterns in body composition

The crude mean BMI values for men and women were 21.5 and 21.8 in 1991, and 21.6 and 22.0 in 1993. Adjusted for the sociodemographic covariates and selection bias, the mean BMI values for 1991 and 1993, men and women, were 21.7

Table 3. Mean[a] BMI, daily energy (kcal), fat (as % of energy), and protein (as % of energy) intakes of elderly Chinese subjects from cross-sectional analyses of the 1991 and 1993 panels of the China Health and Nutrition Survey

	1991				1993			
	Protein (kcal)	BMI (% E)	Energy (%E)	Fat (kg/m²)	Protein (kcal)	Energy (% E)	BMI (% E)	Fat (kg/m²)
Total sample	2328.9	28.3	12.1	21.9	2233.9	28.1	11.1	20.1
Men	2518.1	27.7	12.1	21.7	2386.0	27.8	11.1	19.9
Women	2165.1[b]	28.8	12.1	22.1[b]	2095.8[b]	28.3	11.1	20.2
Age 60–64 years	2470.2	27.9	11.9	22.2	2402.5	27.5	11.3	21.1
Age 65–69 years	2408.8	28.5	12.0	22.0	2286.3[b]	28.7	11.3	20.7[b]
Age 70–74 years	2273.3[b]	28.0	12.3[b]	21.5[b]	2152.4[b]	29.5[b]	11.1	19.7[b]
Age 75+ years	2060.4[b]	28.8	12.3[b]	21.5[b]	1997.7[b]	27.2	10.6	18.1[b]
Low income[d]	2244.3[b]	24.0[b]	11.6[b]	21.1[b]	2183.7	23.6[b]	10.8	20.0
Medium income[c]	2292.3[b]	28.9[b]	12.2	21.7[b]	2259.3	28.1[b]	10.9	20.2
High income[c]	2450.2	31.9	12.4	22.9	2259.0[b]	32.5	11.5	20.0
Rural	2413.2[b]	25.7[b]	12.0[b]	21.4[b]	2295.0[b]	26.0[b]	10.8[b]	19.3[b]
Urban	2227.3	31.4	12.2	22.4	2156.3	30.7	11.5	21.0
P-value for selectivity (athrho)[d]	0.103	0.001	0.000	0.121	0.020	0.011	0.000	0.000

[a]Stratum-specific means were predicted from Heckman–Singer models with age, sex, income and urban/rural status as independent variables in the regression equation for each survey year. [b]Significantly different ($P < 0.05$) from the male, urban, high income or youngest age group in the same year [c]Income tertile cut-offs, 1991: 404.7 and 789.0 Yuan/Year; and 1993: 375.7 and 854.6 Yuan/Year [d]The Heckman–Singer procedure in STATA estimates a probit equation determining whether or not the outcome of interest was observed along with the ordinary least squares (OLS) regression model of interest. The procedure estimates 'Rho' (ρ), the correlation between error terms in the OLS and probit components of the Heckman–Singer model and an associated *P*-value testing the hypothesis that this correlation coefficient (actually the inverse hyperbolic tangent of rho) is 0. If the correlation coefficient is non-zero, then the regression coefficients estimated by the OLS model may be significantly biased due to missing data. The STATA Heckman procedure produces regression coefficients adjusted for this potential selection bias.

Table 4. Mean[a] daily intakes of rice, rice products, edible oil, high-fat red meats and eggs of elderly Chinese subjects from cross-sectional analyses of the 1991 and 1993 panels of the China Health and Nutrition Survey

	1991				1993			
	Rice (g/day)	Edible vegetable oil (g/day)	High-fat red meat (g/day)	Eggs (g/day)	Rice (g/day)	Edible vegetable oil (g/day)	High-fat red meat (g/day)	Eggs (g/day)
Total sample	180.1	34.8	9.8	21.1	276.4	31.0	3.5	22.9
Men	195.3	36.0	10.0	23.0	283.5	31.9	4.0	26.0
Women	166.9	33.7	9.6	19.5	270.0	30.2	3.0	20.0[b]
Age 60–64 years	210.9	35.5	7.5	18.4	288.7	32.6	4.5	19.6
Age 65–69 years	191.7[b]	35.6	9.3	20.8	285.6	31.4	4.0	24.4
Age 70–74 years	170.6[b]	34.9	13.2[b]	21.7	266.7	32.0	3.4	25.6[b]
Age 75+ years	126.1[b]	32.8	11.3[b]	25.5[b]	256.1[b]	27.8	1.5	23.9
Low income[d]	173.3	28.7[b]	5.6[b]	10.7[b]	255.6[b]	26.1[b]	3.2	19.3[b]
Medium income[c]	196.6[b]	35.0[b]	12.1	20.3[b]	299.1	31.6[b]	3.5	20.9[b]
High income[c]	170.3	40.6	11.7	32.4	280.8	35.6	3.7	28.0
Rural	191.6[b]	31.8[b]	8.1[b]	20.0	297.3[b]	30.1	0.2[b]	21.0[b]
Urban	166.3	38.3	11.9	22.5	250.0	32.2	7.6	25.3
P-value for selectivity (athrho)[d]	0.43	0.000	0.08	0.012	0.000	0.003	0.29	0.000

[a]Stratum-specific means were predicted from Heckman–Singer models with age, sex, income and urban/rural status as independent variables in the regression equation for each survey year. [b]Significantly different ($P < 0.05$) from the male, urban, high income or youngest age group in the same year [c]Income tertile cut-offs, 1991: 404.7 and 789.0 Yuan/year; and 1993: 375.7 and 854.6 Yuan/Year [d]The Heckman–Singer procedure in STATA estimates a probit equation determining whether or not the outcome of interest was observed along with the ordinary least squares (OLS) regression model of interest. The procedure estimates 'Rho' (ρ), the correlation between error terms in the OLS and probit components of the Heckman-Singer model and an associated *P*-value testing the hypothesis that this correlation coefficient (actually the inverse hyperbolic tangent of rho is 0). If the correlation coefficient is non-zero, then the regression coefficients estimated by the OLS model may be significantly biased due to missing data. The STATA Heckman procedure produces regression coefficients adjusted for this potential selection bias.

and 22.1, and 19.9 and 20.2, respectively (Table 3). With regard to patterns across strata, mean BMI declined significantly with age group and rural residence in both 1991 and 1993. In 1991 but not 1993, BMI was significantly and positively associated with female gender and income.

Given the U-shaped relationship reported between BMI and mortality risk, linear models with continuous BMI as dependent variable may not reflect meaningful differences in risk. To facilitate interpretation of our results with respect to potential health implications, we categorized BMI into low, middle and higher BMI groups using two sets of reference points (18.5 and 25.0; 22.0 and 27.0), and predicted stratum-specific prevalences from multinomial logistic regression models (Table 4).

Depending on the cut-offs used, the adjusted prevalences varied substantially. In 1991, an estimated 16.0 and 20.2% of the 60–64 and 65–69 years age groups had a BMI less than 18.5, respectively. An estimated 18.5 and 19.5% of the same age groups had BMI over 25.0 in the same year. The corresponding values for the 1993 sample were 12.3 and 13.1, and 21.5 and 18.3%, respectively.

For adults over 70 years of age, higher cut-offs for low BMI and high BMI are thought to be more appropriate. For the 1991 sample, the model indicated 63.0% of the 70–74 years age group and 63.8% of the over 75 years age group had a BMI less than 22.0. The model also predicted that 4.1% of the 70–74 years age group and 6.8% of the over 75 years age group had a BMI greater or equal to 27.0. For the same age groups in the 1993 sample, the adjusted prevalences of BMI below 22.0 were 61.2 and 68.8%, and above 27.0 were 6.0 and 3.8%.

The same patterns observed between-strata with the continuous BMI variable were observed with the categorical variables. For both samples, regardless of the choice of BMI cut-offs, the prevalences of low BMI increased with age, while the prevalences of high BMI generally decreased with age. The urban/rural contrasts were striking, with the predicted prevalence of low BMI approximately 10 or more percentage points lower, and the prevalence of high BMI almost twofold greater in urban areas. Under- and overweight status were significantly related to income tertile in 1991 but not 1993.

Discussion

This paper sought to describe patterns in the diets, activity levels and BMI of two large cross-sectional samples of

Table 5. Prevalence[a] of low, middle and high BMI among elderly Chinese subjects in 1991 and 1993

	BMI Prevalence (%) 1991			BMI Prevalence (%) 1993			BMI Prevalence (%) 1991			BMI Prevalence(%)1993		
	<18.5	18.5-25.0	>25.0	<18.5	18.5-25.0	>25.0	<22.0	22.0-27.0	>27.0	<22.0	22.0-27.0	>27.0
Total sample	19.8	63.5	16.7	16.3	67.5	16.3	59.5	32.2	8.4	59.2	32.7	8.1
Men	20.7	65.3	14.0	16.7	70.1	13.3	62.3	30.1	7.7	62.5	30.8	6.7
Women	19.1	61.8	19.0[b]	15.9	64.9	19.2[b]	57.0	34.0	9.0	56.0	34.4	9.6
Age 60–64 (years)	16.0	65.5	18.5	12.3	66.2	21.5	55.7	34.6	9.6	53.9	34.8	11.3
Age 65–69 (years)	20.2	60.4	19.5	13.1	68.6	18.3	58.5	30.8	10.7	55.7	34.8	9.5
Age 70–74 (years)	19.9	67.7	12.4	15.6	71.0	13.5[b]	63.0	32.9	4.1[b]	61.2	32.8	6.0
Age 75+ years	25.3[b]	60.9	13.8	25.5[b]	65.6	8.91	63.8	29.4	6.8	68 .8[b]	27.3	3.8[b]
Low income[c]	23.2[b]	66.1	10.7[b]	17.9	65.5	16.6	70.1[b]	24.7	5.2	60.6	30.1	9.2
Medium income[c]	21.3	64.6	14.2[b]	14.5	70.0	15 .6	60.1[b]	33.6	6.3[b]	58.6	34.6	6.8
High income[c]	14.7	61.6	23.7	16.3	67.1	16.6	48.7	38.1	13.1	58.2	33.2	8.5
Rural	23.[2b]	65.2	11.6[b]	20.7[b]	68.9	10.4[b]	66.4[b]	26.7	6.9	67.0[b]	27.7	5.3[b]
Urban	15.6	62.6	21.8	10.5	65.9	23.6	51.5	38.7	9.8	49.3	38.9	11.8

[a] Stratum- specific BMI prevalences were predicted from multinomial logistic regression models with age, sex, income and/or urban/rural status as independent variables for each survey year, [b]Significantly different ($P < 0.05$) from the male, urban, high income or youngest age group in the same year, [c]Income tertile cut-offs, 1991: 404.7 and 789.0 Yuan/year; and 1993: 375.7 and 854.6 Yuan/year.

Table 6. Proportion[a] of the elderly Chinese sample with very low, low, medium and high activity levels in 1991 and 1993

	Proportion in each activity level (%) 1991				Proportion in each activity level (%) 1993			
	Very low	Low	Medium	High	Very low	Low	Medium	High
Total sample	33.5	29.0	11.0	26.5	31.3	24.5	9.3	34.9
Men	35.6	24.8	10.3	29.2	33.7	21.5	7.8	37.0
Women	31.5	32.7[b]	11.7[b]	24.1	29.2	27.2[b]	10.7[b]	32.9
Age 60–64 years	22.1	29.7	13.8	34.5	21.0	27.2	10.1	41.6
Age 65–69 years	29.9	30.3	10.4[b]	29.5[b]	30.5	22.4[b]	8.2[b]	3 8.8[b]
Age 70–74 years	38.4	30.4[b]	10.9[b]	20.3[b]	37.4	26.9[b]	10.7[b]	25.0[b]
Age 75+ years	54.5	24.6[b]	7.3[b]	13.6[b]	45.7	20.2[b]	8.2	25.9[b]
Low income[c]	28.2	22.9	16.3[b]	32.6[b]	21.6	23.8[b]	11.0[b]	43.6[b]
Medium income[c]	30.1	33 l[b]	10.5[b]	26.3[b]	31.7	22.7	10.2[b]	35.4[b]
High income[c]	42.6	32.3	7.3	17.9	40.7	28.8	8.0	22.4
Rural	21.7	23.6[b]	12.5[b]	42.1[b]	19.0	18.7[b]	9.9[b]	52.5[b]
Urban	47.8	36.8	9.8	5.7	47.5	33.9	9.4	9.2

[a]Stratum-specific sample proportions in each activity level were predicted from multinomial logistic regression models with age, sex, income and/or urban/rural status as independent variables for each survey year, [b]Significantly different ($P < 0.05$) from the male, urban, high income or youngest age group in the same year, [c]Income tertile cut-offs, 1991: 404.7 and 789.0 Yuan/year; and 1993: 375.7 and 854.6 Yuan/year.

Chinese elderly living in eight provinces of China. Considering Chinese national food consumption patterns and research on the nutrition transition among children and adults in China, sociodemographic differences in energy, fat and protein intake, activity levels and patterns of low and high BMI were anticipated. In exploring for these patterns, this descriptive paper extends previous work on the nutritional status of Chinese adults and provides the first report of anthropometric and dietary data for large samples of Chinese elderly.

Overall picture of nutrient intake and weight status

The observed mean energy and protein intakes appeared adequate, over 95% of the age-, sex- and activity level-specific RDA for both samples. The mean fat intakes of 28% of energy were over the maximum intake level (25.0%) recommended for adults by the Chinese Nutrition Society,[28] although below the level (30%) according to WHO and US standards.

The mean BMI values observed in this study ranged between 18.1 and 22.9 among the various subcategories of the elderly in these analyses and were comparable to those described for elderly Chinese aged 70–79 living in Hong Kong, as well as elderly Chinese over age 70 living in Tianjin.[23,29] Depending on which BMI reference we used, the prevalence of low BMI ranged from just above 15% (using BMI 18.5–25.0 as normal), to as much as 70% (using 22.0–27.0 as normal). Similarly, the prevalence of high BMI ranged from 4 to 24% of both samples. Although accurate and precise estimates of the prevalence of underweight and overweight among the Chinese elderly will depend on the development of appropriate standards for this population, the present results suggest that low BMI among the elderly may be an important public health problem for China, even when the more conservative WHO standards are used.

Consistent cross-sectional patterns in food consumption, nutrient intake and BMI

The expected patterns were apparent with regard to urban/rural residence and income tertile. In both cross-sectional analyses, high income and urban residents consumed more plant oil, high-fat red meats and eggs and derived significantly greater amounts of energy from fat and protein than lower income or rural subjects. In keeping with significantly lower activity levels, urban residents had significantly lower energy intakes than their rural counterparts. As expected, given the decreased activity levels and higher fat intakes in urban areas, high BMI status was significantly more prevalent among urban residents. Low BMI status, according to both definitions, was significantly more prevalent among rural residents. The effect of income was markedly less important for energy and BMI in 1993 compared to 1991. The observed income and urban/rural differences correspond with those described previously for younger adults and elderly Chinese over age 70 living in Tianjin.[3,5,11,12,29,30] Low and high BMI appear to coexist among the elderly Chinese and appear differentially distributed across income and urban/rural strata.

Conclusions

Patterns observed in cross-sectional analyses for the Chinese elderly were similar to those observed for younger Chinese adults. Given the significant proportion of elderly Chinese with a low BMI in both survey years, underweight may constitute a more pressing problem than overweight for the Chinese elderly. As is well known, undernutrition can depress the immune system and promote morbidity, while overnutrition may promote many chronic and degenerative diseases. Both extremes threaten the health and welfare support systems of China. As the demographic and development processes proceed in China and the gaps between age and income groups widen, dietary and anthropometric differences may contribute to the development of health inequalities.

Several methodological problems, related to the use of cross-sectional data, unavailable criteria for normal weight status among the Chinese elderly and selection bias, argue for caution when interpreting these results. This study only reports information about cross-sectional patterns in dietary intake and anthropometry for 1991 and 1993 — not trends between years. Due to the different samples and significant selection bias in both survey years, it was not possible to investigate trends between years and correct for selection bias to provide generalizable results. Optimal measurement and evaluation of change over time requires longitudinal analyses with appropriate control of time-varying covariates and selection bias, which were beyond the scope of this paper (although the CHNS is a longitudinal survey, here we have only presented two cross-sectional panels). The significant selection bias observed in this study appeared related to both under- and overestimation of diet and anthropometric variables and may distort the generalizability of the results, despite our adjustment for this bias. More careful longitudinal work is needed to determine if and how undernutrition and obesity might be a problem for the Chinese elderly at present and in the future.

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