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Dietary pattern and weight change in a 5-year follow-up among Chinese adults: results from the Jiangsu Nutrition Study

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Abstract

The aim of the present study was to examine the association between dietary patterns and weight change prospectively. We followed up 1231 adults aged 20 years and older (mean age 49·3 years) from 2002 to 2007. Food intake was assessed at baseline by an FFQ. Factor analysis was used to identify dietary patterns. Nutrient intake was measured by food weighing plus consecutive individual 3 d food records. Body weight and height were measured. The mean 5-year weight gain among all participants was 0·8 (SD 4·7) kg. The mean weight changes across quartiles of the 'traditional' pattern (rice, fresh vegetables, pork and wheat flour) were 2·0, 0·6, 0·6 and 0·0 kg. The corresponding values were 0·4, 0·5, 0·7 and 1·6 kg across quartiles of the 'vegetable-rich' pattern. No significant association between the 'macho' dietary pattern (meat and alcohol), the 'sweet tooth' pattern (drinks and cake) and weight gain was found. In multivariate linear regression, using the first quartile as the reference, participants in the highest quartile of the 'traditional' pattern had a β of $-2{\cdot}18$ (95 % CI $-2{\cdot}91$, $-1{\cdot}45$) for weight gain. However, the β from weight change of the highest quartile of the 'vegetable-rich' pattern was 1·00 (95 % CI 0·25, 1·74). In conclusion, the 'traditional' dietary pattern was negatively and the 'vegetable-rich' pattern was positively associated with weight gain in Chinese adults.

Key words: Dietary patterns: Weight change: Obesity: Adults: China

Obesity is a major health problem worldwide[1]. Much attention has been drawn to the obesity epidemic because of the high economic burden as well as its association with many non-communicable chronic diseases including diabetes, CHD and cancer. Physical activity and diet are two key determinants of obesity[2].

Extensive research has been done on the association between a single food or nutrient and obesity[2,3]. As foods or nutrients may interact, knowledge on single foods or nutrients in association with weight change has limited value[4]. Comprehensive analyses (e.g. Healthy Eating Index) and use of dietary patterns have become popular approaches[4]. Dietary patterns derived by factor analysis have been found to be associated with weight gain in Western countries[5–7]. A dietary pattern rich in fruits and vegetables has consistently been negatively associated with weight gain, while a Western dietary pattern has been positively associated with weight gain[5–7]. Cross-sectional studies from East Asian countries have shown an association between dietary pattern and overweight/obesity[8–10]. However, to establish a causal link between diet and overweight, longitudinal studies are needed. Nevertheless, longitudinal studies on the association between the traditional Chinese dietary pattern and weight gain are limited. As food culture and cooking methods are different between the Eastern and Western worlds[10], it is of importance to have a clear understanding of this association in the Eastern world.

Randomised control trials show the benefit of a low-carbohydrate, a low-fat or a Mediterranean diet, and weight loss[11,12]. Because of its benefits in regard to obesity and CVD prevention, the Mediterranean diet has attracted wider attention.

The traditional Chinese diet has many similarities with the Mediterranean diet (high intake of vegetables, grains, legumes and high MUFA:SFA ratio), with the exception of a low intake of dairy products and wine[13]. A study from China showed that a high percentage of energy intake from cereals was significantly associated with lower BMI[14]. We previously reported the associations between

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dietary patterns and obesity among Chinese adults in a cross-sectional study. We found a positive association between the vegetable-rich pattern and obesity, while no association was found between the traditional pattern and obesity[10]. Due to the limitation of the cross-sectional design, we could not conclude a causal relationship. Using the same sample, the present study investigates 5-year weight change according to dietary pattern at baseline derived by factor analysis among Chinese adults.

Research design and methods

Sample

The Jiangsu Nutrition Study is an ongoing cohort study investigating the association of nutrition and other factors with the risk of non-communicable chronic disease. The sample was based on a subsample of the Chinese National Nutrition and Health Survey representing Jiangsu Province, and the year 2002 was used as a baseline. The rural sample was selected from six counties (Jiangyin, Taichang, Shuining, Jurong, Sihong and Haimen). From each of the six counties, three smaller towns were randomly selected. The urban sample was selected from the capital cities of two prefectures, Nanjing and Xuzhou; and from each capital city, three streets were randomly selected. The six counties and the two prefectures represented a geographically and economically diverse population. In each town/street, two villages/neighbourhoods were randomly selected, and ninety households were further selected randomly from each village/neighbourhood. All the members in the households were invited to take part in the study. In addition, one-third of the households were interviewed on dietary intake. Written consents were obtained from all the participants. The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Jiangsu Provincial Center for Disease Control and Prevention.

In 2002, 2849 adults aged 20 years and above provided dietary information. In 2007, only 1682 participants could be identified; of these, 1492 participated in the study, and of these, 1282 participants' height and weight were measured. The rest of the participants had either migrated to other cities for temporary work or moved out of the original streets to other streets within the urban area. For the present analysis, we excluded those participants who had extreme values of weight change more than 20 kg (*n* 11) and those who had known diabetes, stroke or cancer at baseline (*n* 40). The final sample in the study consisted of 510 men and 721 women. Compared with the retained participants, those lost to follow-up were generally younger (45·5 *v.* 49·3 years). No differences in mean BMI and energy intake were found.

Data collection and measurements

Participants were interviewed at their homes by health workers using a standard questionnaire. All health workers were intensively trained in meeting and in practical sessions.

Outcome variables (height and weight)

Height and weight were measured both at baseline and at the follow-up. At each study site, health workers measured height and weight according to the standard protocols. Weight was measured without shoes and light indoor clothing to the nearest 0·1 kg by using a beam balance scale. Height was measured to the nearest 0·1 cm by using a stadiometer. BMI was calculated as weight in kg divided by the square of the height in m.

Independent variables (dietary measurements)

Diet during the past year was investigated at baseline by an FFQ with detailed questions about the usual frequency and quantity of intake of thirty-three food groups and beverages[10]. The list of foods was further collapsed into twenty-five main food groups in the analysis because of the low intake of some items. Portion size for each food was established by reference to food models. Subjects were asked to recall the frequency of consumption of individual food items (number of times/d, number of times/week, number of times/month and number of times/year) and the estimated portion size using local weight units (liang (50 g)) or natural units (cups). Intakes of foods were converted into local weight units (liang) or natural units (cups, for beer and beverages) per d and were used in further analysis. These food intake variables were standardised (mean 0 (SD 1)) before performing the factor analysis.

The FFQ was validated[15,16] and reported to be a useful method for the collection of individual food consumption information in face-to-face interviews, but not in self-administered surveys due to the current educational level of the majority of the Chinese population.

Dietary patterns (main independent variables) were identified by factor analysis using the standard principal component analysis method. Factors were rotated with an orthogonal (varimax) rotation to improve interpretability and minimise the correlation between the factors. The number of factors retained from each food classification method was determined by eigenvalue (>1), scree plot, factor interpretability and the variance explained ($>5\%$) by each factor. Labelling of the factors was primarily descriptive and based on our interpretation of the pattern structures.

Factor analysis was done using Chinese servings/d as input variables. Factor loadings are equivalent to simple correlation between the food items and the factor.

Higher loadings (absolute value) indicate that the food shares more variance with that factor. The sign of the loading determines the direction of the relationship of each food with the factor. Food groups with absolute values < 0·20 are not presented for simplicity.

Participants were assigned pattern-specific factor scores. Scores for each pattern were calculated as the sum of the products of the factor loading coefficients and standardised weekly intake of each food associated with that pattern.

Nutrient and vegetable oil intakes were measured at baseline both by food weighing and by consecutive individual 3 d food records. We did not consider under- and over-reporting of energy intake as an issue of concern because any unreliable data were checked by the health workers during the survey. Food consumption data were analysed using the Chinese Food Composition Table[17].

Covariates

Smoking and drinking. Cigarette smoking was assessed by asking the participants about the frequency of daily cigarette smoking. Alcohol consumption was assessed by asking the participants about the frequency and amount of alcohol/beer intake.

Physical activity and inactivity. Information on physical activity was collected using a validated physical activity questionnaire covering a time period of 1 year[18]. Questions on daily commuting to and from work were categorised into three categories: (1) using motorised transportation or not (0 min of walking or cycling); (2) walking or bicycling 1–29 min; (3) walking or bicycling for ≥30 min. Daily leisure-time physical activity was classified into three categories: 0; 1–29; ≥30 min.

Socio-economic status. Education was recoded into three categories based on six categories of educational levels in the questionnaire: 'low': illiteracy, primary school; 'medium': junior middle school; 'high': high middle school or higher. Occupation was recoded into manual or non-manual based on a question with twelve occupational categories.

Statistical analyses

Factor scores were divided into quartiles, implying increased intake from quartile 1 to quartile 4. The χ^2 test was used to compare the difference between categorical variables. Multivariate linear regression was used to determine the association between dietary pattern and weight change. Three stepwise models were used: model 1 adjusted for age and sex; model 2 further adjusted for education, occupation, active commuting, leisure-time physical activity, smoking and alcohol drinking; model 3 further adjusted for energy intake. Factor analysis was performed using SPSS 11.0 (SPSS, Inc., Chicago, IL, USA). All the other analyses were performed using STATA 10 (Stata Corporation, College Station, TX, USA). Statistical significance was considered when $P < 0.05$ (two-sided).

Results

Four dietary patterns were obtained by factor analysis. Factor loadings for the four dietary patterns are presented in Table 1. Factor 1 ('macho') was characterised by various kinds of animal foods and alcohol, i.e. foods commonly eaten by men. The 'traditional' pattern (factor 2) loaded heavily on rice and fresh vegetables and inversely on wheat flour. Factor 3 ('sweet tooth') contained cake, milk, yogurt and drinks, and more women than men could be associated with this pattern. Factor 4 ('vegetable-rich' pattern) included whole grains, fruits, root vegetables, fresh and pickled vegetables, milk, eggs and fish. The four factors explained 28·5 % of the variance in intake (9·8, 8·0, 5·5 and 5·2 % for factor 1 to factor 4, respectively).

Table 1. Factor loadings for the four dietary patterns among adults in Jiangsu, China

Factor 1: 'macho'		Factor 2: 'traditional'		Factor 3: 'sweet tooth'		Factor 4: 'vegetable-rich'	
Food or food group	Factor loadings	Food or food group	Factor loadings	Food or food group	Factor loadings	Food or food group	Factor loadings
Poultry	0·55	Rice	0·78	Cake	0·59	Whole grains	0·56
Beer	0·54	Fresh vegetables	0·61	Juice	0·57	Fruits	0·47
Alcohol	0·50	Pork	0·38	Beverages*	0·48	Tofu	0·48
Beef, lamb	0·45	Fish	0·24	Milk	0·47	Pickled vegetables	0·42
Deep-fried products	0·45	Pickled vegetables	0·20	Yogurt	0·43	Root vegetables	0·36
Pork	0·43	Root vegetables	−0·28	Beef, lamb	0·30	Wheat flour	0·32
Liver	0·43	Wheat flour†	−0·75	Nuts	0·26	Milk	0·31
Eggs	0·37			Poultry	0·25	Fresh vegetables	0·29
Fish	0·26			Fruits	0·22	Eggs	0·30
Nuts	0·24			Pickled vegetables	−0·22	Milk powder	0·23
Fruits	0·24			Alcohol	−0·31	Fish	0·22
Tofu	0·21					Rice	−0·26
						Beer	−0·22
Variance explained (%)	9·8		8·0		5·5		5·2

* Beverages include soft drinks, coffee and tea.
† Wheat flour includes noodles and steamed dumplings.

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There were significant differences in the intake of fruits, vegetables, rice, wheat flour, whole grains, pork and fish across quartiles of the 'traditional' dietary pattern (Table 2). Education was positively associated with this pattern. A clear increasing trend of the intake of fat was seen across quartiles of the 'traditional' pattern from low to high. Participants in the first quartile of this pattern had the highest intake of wheat flour and dietary fibre compared with the other groups. However, no significant difference was found in the intake of vegetable oil across quartiles of this pattern. There was a significant negative association between the 'traditional' pattern and energy density.

The food and nutrient intakes across quartiles of the 'vegetable-rich' dietary pattern have been shown

Table 2. Food and nutrient intakes across quartiles (Q) of the dietary patterns at baseline in Chinese adults
(Mean values and their standard errors or percentages, *n* 1231)*

	Intake of dietary pattern quartiles								
	Q1		Q2		Q3		Q4		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	*P* for trend
'Traditional' dietary pattern									
Fresh vegetables (g/d)	177	8	225	8	272	8	365	8	<0·001
Fruits (g/d)	58	5	44	5	45	5	80	5	<0·001
Rice (g/d)	123	6	299	6	382	6	478	6	<0·001
Wheat flour (g/d)	298	6	40	6	20	6	21	6	<0·001
Whole grains (g/d)	15	1	5	1	2	1	3	1	<0·001
Root vegetables (g/d)	21	1	10	1	10	1	9	1	<0·001
Pickled vegetables (g/d)	18	2	14	2	16	2	26	2	<0·001
Pork (g/d)	21	2	33	2	43	2	59	2	<0·001
Fish (g/d)	24	2	28	2	30	2	35	2	<0·001
Energy density (kJ/g)†	8·7	0·1	7·9	0·1	8·1	0·1	7·9	0·1	<0·001
Energy (kJ/d)	10 002	142	9126	142	9750	142	10 207	142	<0·001
Protein (g/d)	72	1	69	1	74	1	75	1	<0·001
Carbohydrate (g/d)	345	5	283	5	308	5	332	5	<0·001
Fat (g/d)	75	2	80	0	85	2	87	2	<0·001
Fat energy (%)	28	1	33	1	33	1	32	1	<0·001
Fat energy >30 % (%)	40	3	64	3	63	3	58	3	<0·001
Fat distribution (%)									
Plant foods	77·5	1·2	60·4	1·2	61·3	1·2	61·5	1·2	<0·001
Animal foods	22·5	0·9	39·9	0·9	39·0	0·9	37·9	0·9	<0·001
Vegetable oil (g/d)	42	2	39	2	40	2	43	2	0·184
Fibre (g/d)	18·7	0·5	8·4	0·5	9·3	0·5	9·9	0·5	<0·001
Age (years)	47·9	0·7	50·8	0·8	48·4	0·8	48·8	0·7	0·036
Men (%)	41·2		32·1		42·2		50·2		<0·001
Low education (%)	60·1		53·6		51·6		47·6		0·026
Manual job (%)	57·1		43·1		51·0		56·4		0·002
Active commuting‡ (%)									
None	33·8		53·9		39·6		35·2		
1–30 min/d	43·8		40·3		54·6		55·4		<0·001
> 30 min/d	22·4		5·8		5·8		9·5		
Leisure-time physical activity (%)									
None	91·2		92·5		93·2		89·6		
1–30 min/d	4·6		4·2		4·2		4·6		0·543
> 30 min/d	4·2		3·3		2·6		5·9		
Smoker (%)	25·7		25·0		25·3		24·0		0·104
Alcohol drinker (%)	27·0		23·7		24·0		24·8		0·788
'Macho' pattern									
Age (years)	52·5	0·8	49·1	0·7	47·7	0·8	46·7	0·7	<0·001
Men (%)	21·4		35·7		44·2		64·5		<0·001
Low education (%)	70·1		52·9		51·3		38·4		<0·001
Energy intake (kJ/d)	10 031	147	9570	142	9536	142	9951	147	0·024
'Sweet tooth' pattern									
Age (years)	48·6	0·7	50·7	0·7	49·8	0·8	46·9	0·8	0·002
Men (%)	61·4		36·7		32·8		34·9		<0·001
Low education (%)	53·9		62·3		55·8		40·7		<0·001
Energy intake (kJ/d)	10 655	142	9863	142	9515	142	9055	142	<0·001
'Vegetable-rich' pattern									
Age (years)	49·5	0·7	48·2	0·7	49·4	0·8	48·9	0·7	0·570
Men (%)	48·4		42·9		34·7		39·7		0·006
Low education (%)	59·1		51·9		51·6		50·2		0·016
Energy intake (kJ/d)	9633	142	9524	142	9775	142	10 157	142	0·012

* All values of food and nutrient intakes are adjusted for age.
† Calculated from food only (excludes beverages) based on the FFQ.
‡ Active commuting including walking and cycling.

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elsewhere[10]. Across quartiles of the 'vegetable-rich' pattern, the intake of energy, wheat flour and vegetable oil increased. There was a significant inverse association between the 'sweet tooth' pattern and energy intake. Men were more likely to have a high intake of the 'macho' pattern but less likely to have a high 'sweet tooth' pattern.

Fig. 1 shows the mean 5-year weight change according to quartiles of the dietary patterns. After adjustment for age, sex and baseline weight, the 'traditional' dietary pattern was inversely associated with weight gain, while the 'vegetable-rich' pattern was positively associated with weight gain. The mean 5-year weight gain among all participants was 0·8 (SD 4·7) kg. The mean weight changes across quartiles of the 'traditional' pattern were 2·0, 0·6, 0·6 and 0·0 kg (P for trend $<0·001$). The corresponding values were 0·4, 0·5, 0·7 and 1·6 kg across quartiles of the 'vegetable-rich' pattern (P for trend$=0·004$). No significant associations of the 'macho' and 'sweet tooth' patterns with weight gain were found. There was no U-shaped association between the 'sweet tooth' pattern and weight gain when we put the square term of the 'sweet tooth' score as a continuous variable in the regression model (data not shown). As there was a large difference in the intake of wheat flour across quartiles of the 'traditional dietary pattern', we stratified the analysis by low and high intakes of wheat flour. A similar association between the 'traditional' pattern and weight gain was found. The line for low wheat flour intake sloped less than the unstratified curve for the 'traditional' pattern shown in Fig. 1 (data not shown).

In multivariate linear regression (Table 3), using the first quartile as the reference, participants in the highest quartile of the 'traditional' dietary pattern had a β of $-2·18$ (95 % CI $-2·91$, $-1·45$) for weight gain. However, the β for weight change of the highest quartile of the 'vegetable-rich' pattern was 1·00 (95 % CI 0·25, 1·74). Mutually adjusting for the other dietary patterns did not change the results (data not shown).

In the stratified multivariate analyses (Table 4), an inverse association between the 'traditional' dietary pattern and weight gain was present in subjects aged <40 years and ≥ 40 years, in non-smokers and smokers, in overweight and normal-weight subjects, in alcohol drinkers and non-drinkers, and in men and women. There were no significant interactions between any of the above factors and the 'traditional' dietary pattern with weight gain. Among the overweight subjects at baseline, those who had the highest intake of the 'traditional' pattern had the lowest weight gain: compared with the first quartile, the fourth quartile had a β of $-2·63$ (95 % CI $-3·94$, $-1·32$) for weight gain. Physical activity did not modify the association.

Discussion

The rice-rich 'traditional' dietary pattern was inversely associated with weight gain among adults in China in a 5-year follow-up in the Jiangsu Nutrition and Health Study. The opposite relationship was found in regard to the 'vegetable-rich' dietary pattern. The association between weight loss and the 'traditional' pattern across quartile intakes seemed to be stronger among overweight subjects than normal-weight subjects. This association was not modified by age, sex, BMI, smoking, alcohol drinking and other dietary patterns.

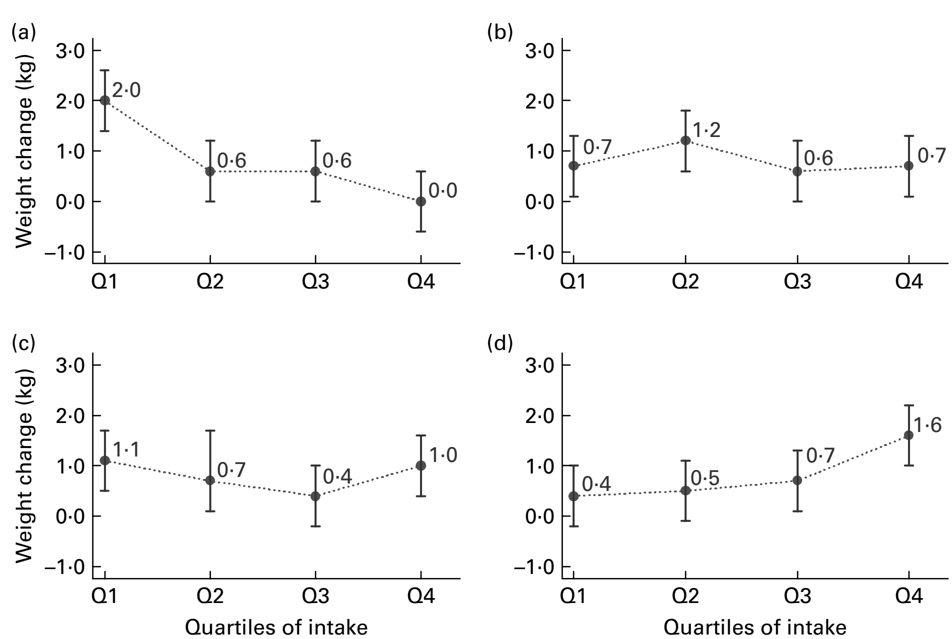

Fig. 1. Mean 5-year weight change (95 % CI) according to quartiles (Q1—Q4) of the dietary patterns. Means were adjusted for age, sex and baseline weight. (a) Traditional dietary pattern ($P<0·001$), (b) macho dietary pattern ($P=0·300$), (c) sweet tooth dietary pattern ($P=0·164$) and (d) vegetable-rich dietary pattern ($P=0·004$).

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Table 3. Linear regression β coefficients (95 % CI) for quartiles (Q1–Q4) of the four dietary patterns predicting 5-year change in weight in 1231 adults participating in the Jiangsu Health Cohort study†

(β Coefficients and 95 % confidence intervals)

	5-Year change in wt (kg)							
	Q1 (*n* 308)	Q2 (*n* 308)		Q3 (*n* 308)		Q4 (*n* 307)		
	Reference	β	95 % CI	β	95 % CI	β	95 % CI	*P* for trend
Macho pattern								
Adjusted for age and sex (model 1)	0	0·49	−0·23, 1·22	−0·14	−0·87, 0·60	−0·08	−0·85, 0·69	0·474
Multivariate adjusted (model 2)	0	0·59	−0·14, 1·33	−0·04	−0·79, 0·71	−0·13	−0·96, 0·69	0·434
Multivariate adjusted + energy (model 3)	0	0·59	−0·15, 1·32	−0·05	−0·80, 0·70	−0·12	−0·95, 0·70	0·439
Traditional pattern								
Adjusted for age and sex (model 1)	0	−1·46*	−2·17, −0·75	−1·45*	−2·16, −0·75	−2·05*	−2·76, −1·34	<0·001
Multivariate adjusted (model 2)	0	−1·56*	−2·30, −0·83	−1·45*	−2·17, −0·72	−2·10*	−2·83, −1·37	<0·001
Multivariate adjusted + energy (model 3)	0	−1·53*	−2·27, −0·80	−1·47*	−2·20, −0·75	−2·18*	−2·91, −1·45	<0·001
Sweet tooth pattern								
Adjusted for age and sex (model 1)	0	−0·42	−1·15, 0·30	−0·77	−1·50, −0·04	−0·13	−0·86, 0·60	0·548
Multivariate adjusted (model 2)	0	−0·40	−1·16, 0·35	−0·57	−1·34, 0·21	−0·09	−0·88, 0·70	0·802
Multivariate adjusted + energy (model 3)	0	−0·38	−1·13, 0·38	−0·52	−1·29, 0·26	−0·03	−0·83, 0·77	0·93
Vegetable-rich pattern								
Adjusted for age and sex (model 1)	0	0·00	−0·71, 0·72	0·26	−0·46, 0·97	1·15*	0·44, 1·87	0·001
Multivariate adjusted (model 2)	0	−0·04	−0·75, 0·68	0·35	−0·37, 1·08	1·03*	0·28, 1·77	0·004
Multivariate adjusted + energy (model 3)	0	−0·05	−0·77, 0·67	0·32	−0·41, 1·04	1·00*	0·25, 1·74	0·005

*** *P*<0·01.

† All the models were adjusted for baseline weight. Multivariate model adjusted for variables in model 1 and smoking (yes/no), drinking (yes/no), active commuting (no, 1–30 and >30 min/d), leisure-time physical activity (no, 1–30 and >30 min/d), education (low, medium and high) and occupation (manual/non-manual).

A large difference in the intake of rice and wheat flour was found across quartiles of the 'traditional' dietary pattern. It represented two different sub-patterns with two different staple foods in inverse proportions, i.e. rice and wheat. Rice is a low-energy food that contributes to the bulk of the traditional diet. Compared with wheat, rice absorbs more water when cooked. In addition, different cooking methods are used in preparing these two staple foods. For instance, steamed rice contains twice the amount of water and half of the energy compared with steamed bread[17]. Thus, the energy density of the rice staple diet is usually lower than the one based on wheat. Since the content of wheat was only predominant in the first quartile of this dietary pattern, this may partly explain the negative association between the 'traditional' pattern and weight gain in the present study. It is known that high energy density of the diet is related to obesity[19,20]. Another possible explanation of the negative relationship between the 'traditional' pattern and weight gain could be the intake of vegetables. The intake of fresh vegetables in the fourth quartile of the 'traditional' pattern was twice that of the first quartile. A usual cooking method for vegetables in the study area is stir-frying with vegetable oil, which would increase energy density. Intake of fried foods is found to increase the risk of obesity[10,21]. However, the present findings revealed no significant differences in vegetable oil intake across quartiles of the 'traditional' pattern, indicating alternative ways of cooking, regardless of intake of vegetables. Thus, this pattern may help to prevent weight gain even if the mean energy intake from fat is high. In fact, stir-frying is usually used to cook wheat-based staple foods in the area, while steam or water, rather than oil, is used for the cooking of rice-based foods.

The difference in energy intake across quartiles in the 'traditional' dietary pattern was rather small, implying that this difference cannot explain the relationship with weight gain. Also, this association could not be explained by fat intake, since a higher intake of the 'traditional' pattern was associated with a higher intake of fat. Intake of fibre was the highest among people in the first quartile of the 'traditional' pattern. Thus, the benefit of weight maintenance of the traditional dietary pattern was not related to dietary fibre.

Our finding is consistent with a study from Brazil, which showed that a traditional dietary pattern with a high intake of rice was related to a lower risk of obesity[22]. It is also consistent with a study in China, which showed that

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Table 4. Stratified regression coefficients (95 % CI) for weight change according to the intake of 'traditional' dietary pattern quartiles*
(β Coefficients and 95 % confidence intervals)

	Quartiles of the 'traditional' dietary pattern							
	Q1	Q2		Q3		Q4		
	Reference	β	95 % CI	β	95 % CI	β	95 % CI	*P* for trend
BMI (kg/m^2)								
≥ 24 (*n* 487)	0	−0·99	−2·35, 0·38	−1·92	−3·22, −0·62	−2·63	−3·94, −1·32	<0·001
< 24 (*n* 744)	0	−1·70	−2·56, −0·83	−1·27	−2·12, −0·41	−1·87	−2·74, −0·99	<0·001
Smoking								
Non-smokers (*n* 897)	0	−1·91	−2·74, −1·08	−1·71	−2·52, −0·90	−2·28	−3·11, −1·44	<0·001
Smokers (*n* 334)	0	−0·51	−2·16, 1·13	−0·75	−2·40, 0·91	−1·78	−3·35, −0·20	0·025
Alcohol drinking								
Yes (*n* 306)	0	−0·66	−2·24, 0·92	−0·63	−2·17, 0·92	−1·62	−3·13, −0·12	0·045
No (*n* 925)	0	−1·92	−2·77, −1·07	−1·77	−2·60, −0·93	−2·32	−3·17, −1·47	<0·001
Sexes								
Men (*n* 510)	0	−0·77	−2·17, 0·64	−1·26	−2·57, 0·04	−2·32	−3·59, −1·05	<0·001
Women (*n* 721)	0	−2·09	−2·94, −1·23	−1·69	−2·56, −0·83	−2·04	−2·95, −1·14	<0·001
Age (years)								
< 40 (*n* 321)	0	−0·92	−2·41, 0·57	−2·12	−3·51, −0·73	−2·29	−3·75, −0·82	0·001
≥ 40 (*n* 910)	0	−1·58	−2·45, −0·71	−1·13	−2·00, −0·25	−2·00	−2·86, −1·14	<0·001
Job								
Manual (*n* 639)	0	−1·66	−2·70, −0·62	−2·06	−3·04, −1·07	−2·50	−3·47, −1·53	<0·001
Non-manual (*n* 592)	0	−1·36	−2·43, −0·29	−0·87	−1·96, 0·22	−1·68	−2·82, −0·53	0·017

* Adjusted for variables of the multivariate model (model 3) in Table 3. Stratification variables were based on baseline information.

people having the rice- and vegetable-rich 'Green Water' food cluster had a lower prevalence of overweight/obesity compared with the wheat-rich 'Yellow Earth' food cluster (18 *v.* 27 %)[23]. However, a positive association between the rice-based dietary pattern and BMI was reported in Japanese[8] and in Hispanic elders[24]. Further research is needed to unravel the mechanisms behind this association.

The present study showed that the association between weight loss during the 5 years of follow-up and the traditional dietary pattern seemed to be stronger among overweight subjects than among normal-weight subjects. Whether this finding can be generalised as a way to prevent weight gain in other populations is of interest.

A positive association between the 'vegetable-rich' dietary pattern and weight gain was found in the present study. It confirms our previous cross-sectional findings of a relationship between a vegetable-rich dietary pattern and obesity[10]. We hypothesised that this association could be linked to vegetable oil intake increasing across quartiles of the 'vegetable-rich' pattern[10]. In addition, this may also be explained by the difference in the intake of rice and wheat flour across quartiles of the 'vegetable-rich' pattern, which was opposite to that of the 'traditional' pattern[10], implying a higher intake of wheat in the highest quartile of the 'vegetable-rich' pattern. Further research is needed to understand the association. The food items included in this dietary pattern are recommended by the Chinese Nutrition Society. Thus, the finding has public health significance.

The limitation of the study is the high rate of those lost to follow-up due to migration and city construction. The rapid economic development in the province has caused a large proportion of rural inhabitants to move to the city in search of jobs. At the same time, some people have moved out of the city during the past 10 years due to a high percentage of old houses that have been demolished in order to build new buildings or roads. However, there was no significant difference in the mean BMI between those lost to follow-up and those retained, and thus unlikely to bias the association between dietary pattern and weight change. The second limitation of the study is the use of self-reported physical activities. However, this measurement has been previously validated and found satisfactory. Using posterior approaches to defining dietary patterns has its limitation. The defined dietary patterns are strongly affected by subjective analytic decisions, which are common in all factor analyses. The FFQ was validated at the national level, but the validation study did include samples from the study area. Furthermore, the possible change in dietary habits was not analysed in the present paper. However, it is assumed that the FFQ based on the previous year's dietary habits is a good proxy for dietary habits during the 5-year period, since dietary habits have been found to be reasonably stable through the life course[25]. For the same reason, the use of 3 d individual food records was necessary to estimate total energy in order to be able to adjust for this variable in the analysis of independent association between dietary pattern and weight change. It has been shown earlier that there is a good correlation between the FFQ and the 3 d food record[15,16]. The strength of the study is that it covered participants using both rice and wheat flour as staple foods. It was different from the Shanghai Men's Study, where the majority of the participants were using rice as

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their staple food[9]. The strength of the present study is that weight was measured by health workers; thus under-reporting of weight was not a problem. Stratified analyses showed consistent results.

In conclusion, the 'traditional' dietary pattern was negatively associated with weight gain and the 'vegetable-rich' pattern was positively associated with weight gain in Chinese adults. More research is needed to reveal the mechanisms involved in explaining these associations.

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