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HOW DIETARY PATTERNS ARE RELATED TO INFLAMMAGING AND MORTALITY IN COMMUNITY-DWELLING OLDER CHINESE ADULTS IN HONG KONG – A PROSPECTIVE ANALYSIS

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Abstract: *Introduction:* Studies examining dietary patterns and inflammageing in relation to mortality are limited. *Objective:* We examined the influence of various dietary patterns on all-cause and cardiovascular disease (CVD) mortality, taking into account demographics, lifestyle factors, and serum inflammatory markers. *Methods:* We conducted multivariate Cox regression analyses using data from a cohort of community-dwelling older Chinese adults (1,406 men, 1,396 women) in Hong Kong. Baseline interviewer administered questionnaires covered dietary intake estimation and dietary pattern generation from the food frequency questionnaire, demographic and lifestyle factors, cognitive function and depressive symptoms. Serum high-sensitivity C-reactive protein (hsCRP) and 25-hydroxyvitamin D (25OHD) were measured. All-cause and CVD mortality data at 14-year follow up were retrieved from an official database. *Results:* In men, higher hsCRP level was associated with lower Diet Quality Index-International (DQI-I) score, Mediterranean-DASH Intervention for Neurodegenerative Delay Diet (MIND) score, Okinawan diet score, "vegetables-fruits" pattern score and "snacks-drinks-milk" pattern score. Higher serum 25OHD level was associated with higher Mediterranean Diet Score (MDS) but lower "snacks-drinks-milk" pattern score. None of the dietary pattern scores was associated with all-cause or CVD mortality after adjusting for all covariates. In women, hsCRP level and serum 25OHD level were not associated with any dietary patterns. Higher DQI-I score (HR=0.77 (95% CIs: 0.59, 0.99) highest vs. lowest tertile, p-trend=0.038) and Okinawan diet score (HR=0.78 (95% CIs: 0.61, 1.00) highest vs lowest tertile, p-trend=0.046) was associated with a lower risk of all-cause mortality, whereas higher MIND score (HR=0.63 (95% CI: 0.36, 1.09) highest vs. lowest tertile, p-trend=0.045) was associated with a reduced risk of CVD morality in the multivariate adjusted model. *Conclusion:* Higher DQI-I score and Okinawan diet score were associated with a lower risk of all-cause mortality, and higher adherence to the MIND diet was related to a reduced risk of CVD mortality in community-dwelling Chinese older women.

Key words: Dietary pattern, diet quality, mortality, cardiovascular disease, Chinese.

Introduction

Diet plays an important role in health status and is one of the well-known modifiable risk factors for preventing deaths due to major chronic diseases, such as cardiovascular diseases (CVD) and stroke (1). Since diet is a combination of long-term, multiple exposures of food and nutrients, the dietary pattern approach based on existing patterns and/or that generated from a local population using principal component analysis (2-4) is preferred over the single nutrient/food group approach to examine the role of diet on chronic diseases and mortality.

Many dietary patterns, such as the Mediterranean diet and the prudent dietary pattern which may affect the inflammageing process and risk of chronic diseases and mortality have been documented (1, 5, 6). Inflammatory markers such as C-reactive protein (CRP), is considered to be a marker of 'inflammageing' and is associated with many age-related chronic diseases (7). Meanwhile, the inflammatory process may be modulated by selected nutrients such as omega-3 fatty acids, vitamin D and antioxidants (8-10).

Variations in disease incidence and mortality among different ethnic groups and geographic regions may be attributed by the cultural diversity of population diets. Available studies examining the role of dietary patterns on chronic diseases and mortality were mainly conducted in middle-aged Caucasian adults (1, 11) and data regarding Chinese, in particular for older adults are limited. A greater adherence to the Chinese Food Pagoda or the US dietary guidelines which was characterized by a balanced diet with diverse and adequate nutrients and food intakes was reported to lower the risk of total mortality in Chinese adults (12). A greater intake of plant-derived food and associated nutrients as reflected by a higher Healthy Ageing Nutrition Index (HANI) was also linked with a lower mortality risk in free-living older Taiwanese (13). However, both studies have not included any inflammatory markers in the analysis. Based on data from the Mr and Ms Os study cohorts consisting of 4,000 Chinese people aged 65 years and over in Hong Kong, we examined the influence of various dietary patterns on all-cause and CVD mortality, taking into account age, gender, lifestyle risk factors, as well as serum levels of inflammatory marker (i.e. CRP) and other factors that may relate to inflammation (i.e. vitamin D).

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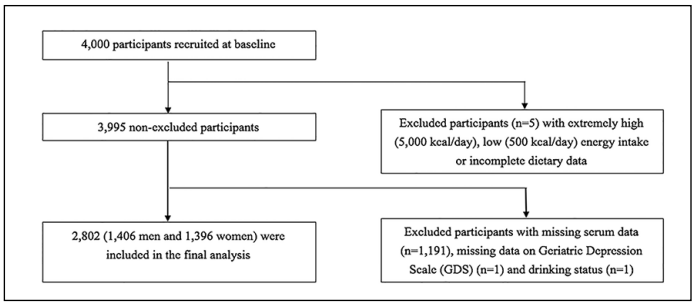
Subjects and methods

Participants

Subjects were participants of a prospective cohort study examining the risk factors for osteoporosis in Hong Kong (14). 2,000 men and 2,000 women aged 65 years and over living in the community were recruited between 2001 and 2003 by placing recruitment notices in community centers for the older people and housing estates, using a stratified sample so that approximately 33% would be in each of these age groups: 65-69, 70-74, 75+. Participants were volunteers and were able to walk or take public transport to the study site. Compared with the general population in this age group, participants had higher educational level (12–18% vs. 3–9%) with tertiary education in the age groups 80+, 75–79,70–74, and 65–69 years (15). This study followed the guidelines laid down in the Declaration of Helsinki, and was approved by the Clinical Research Ethics Committee of the Chinese University of Hong Kong. Written informed consent was obtained from all subjects. Among 4,000 subjects, 5 subjects were excluded due to extremely high (5,000 kcal/day), low (500 kcal/day) energy intake or incomplete dietary data. Moreover, those with missing serum data (n=1,191), as well as data on Geriatric Depression Scale (GDS) (n=1) and drinking status (n=1) were excluded. The final sample included in the analysis was 1,406 men and 1,396 women (Figure 1).

Figure 1
Participant flow chart



A standardized, structured interview was performed to collect information on age, gender, education level, marital status, living status, supplement use, smoking habit, alcohol use and medical history. Physical activity was assessed by the Physical Activity Scale for the Elderly (PASE) (16). This is a 12-item scale measuring the average number of hours per day spent in leisure, household, and occupational physical activities over the previous 7-day period. Activity weights for each item were determined based on the amount of energy spent, and each item score was calculated by multiplying the activity weight with daily activity frequency. A composite PASE score of all the items was calculated, a higher score reflecting higher physical activity level.

Cognitive function was assessed by trained research staff using the cognitive part of the Community Screening Instrument for Dementia (CSID) (17), validated in different cultural and educational settings (17). A summary score ranged from 0 to 33 was generated, with higher score meaning better cognitive function. Three categories of cognitive function were classified based on the corresponding CSID cutoff values: normal (>= 29.5), borderline (28.4-29.49), and probably dementia (<28.4).

Depressive symptoms was assessed by face-to-face interviews using a validated Chinese version of the GDS (18, 19). The GDS short form consists of 15 questions relevant to depression, such as motivation, self-image, losses, agitation and mood. A summary score ranged from 0 to 15 was generated, and a cut-off of 8 or more was used to define the presence of depressive symptoms.

Dietary intake was assessed at baseline using a validated food frequency questionnaire (FFQ) developed in a population survey with participants aged between 25 and 74 years, the validity of which has been described elsewhere (20). Mean nutrient quantitation per day was calculated using food composition tables derived from McCance and Widdowson (21) and the Chinese Medical Sciences Institute (22). The FFQ consisted of 280 food items. Each participant was asked to complete the questionnaire – the food item, the size of each portion, the number of times of consumption each day and each week, using the past 12 months prior to the interview as a reference period. Portion size was explained to participants using a catalogue of pictures of individual food portions. For seasonally consumed vegetables and fruits, participants were further asked about the months of food consumption over the past year. The amount of cooking oil was estimated according to the usual cooking methods of preparing standardised portion of different foods and the usual portion of different foods consumed by the participants.

Dietary patterns derived by factor analysis

Individual food items from the FFQ were aggregated into 32 food groups based on similarity of type of food and nutrient composition. The food groups were energy adjusted by dividing the energy intake from each food group by total energy intake and multiplying by 100, and were expressed as percentage contribution to total energy. The factor scores for each pattern were calculated for each subject by summing intakes of food items weighted by their factor loadings. A higher score indicated greater conformity with the pattern being calculated. Factor analysis identified three dietary patterns in men and women: vegetables-fruits pattern, snacks-drinks-milk products pattern, and meat-fish pattern (2).

Diet Quality Index-International (DQI-I)

The Diet Quality Index-International (DQI-I) was used to assess the quality of diet (23), since it is an indicator of dietary patterns in relation to health. The DQI-I has also been used to evaluate the quality of diet in a Chinese population (24). Four major aspects of the diet are assessed: variety, adequacy,

moderation and overall balance, each with subcomponents. The range is 0–100, with high score indicating high quality. In this study, we did not have sufficient information to calculate the category of empty-calorie foods under the aspect 'moderation'. Therefore, the range of score for moderation was 0–24 instead of 0–30, and the DQI-I total score was 0–94 instead of 0–100.

The Mediterranean Diet Score (MDS)

Adherence to the Mediterranean diet was calculated using the revised method described by Trichopoulou et al. (2003) (25). Essentially, adherence is represented by a scale where a value of 1 was assigned to consumption of food groups considered beneficial to health at or above the sex-specific median (vegetables, legumes, fruits and nuts, cereal, fish and monosaturated to saturated lipids ratio) and below the median for food groups presumed to be detrimental to health (meat, poultry and dairy products). The component of ethanol consumption was scored 1 if daily consumption was between10 and 50g for men or 5 and 25g for women. Therefore, the total MDS ranged from 0 (minimal adherence to the traditional Mediterranean diet) to 9 (maximal adherence).

The Dietary Approaches to Stop Hypertension (DASH) score

The DASH diet emphasizes foods rich in protein, fiber, potassium, magnesium, and calcium, such as fruits and vegetables, beans, nuts, whole grains and low-fat dairy, limiting foods high in saturated fat and sugar (26). A DASH score based on the score developed by Mellen et al. (27) was used to assess accordance with the DASH dietary pattern. The score is based on DASH target intakes for nine nutrients including total fat, saturated fat, protein, fiber, cholesterol, calcium, magnesium, potassium and sodium. Achieving each nutrient target was given a score of 1, and meeting a nutrient target which was intermediate between the DASH target and the nutrient content of the diet of the control group in the DASH trial was given a score of 0.5. The total DASH score was generated by summing the score for each nutrient target with a range from 0 to 9. Higher total DASH score indicates better DASH accordance.

The Mediterranean-DASH Intervention for Neurodegenerative Delay diet (MIND) score

This diet is based on the Mediterranean and DASH diets, with the additional emphasis on ten food groups that is related to slower decline in cognitive abilities: green leafy vegetables, other vegetables, nuts, berries, beans, whole grains, seafood, poultry, olive oil and wine and five unhealthy food groups (red meats, butter and stick margarine, cheese, pastries and sweets, and fried/fast food) (28). A score of 0, 0.5 or 1 was assigned to each food group according to the frequency and portion consumed except for olive oil (28). For olive oil, score of 1 was given if it was used as usual primary oil at home to give a total score of 15 (28). In this study, we did not have enough information to identify use of olive oil as primary oil and the consumption frequency of fish (not fried), beans, poultry, red meat and products, and fast fried foods. Therefore the maximum score of MIND in this study was 9 instead of 15. Higher total MIND score indicates better MIND accordance.

The Okinawan diet score

The traditional Okinawan diet is anchored by root vegetables, with relatively low calorie intake and shares many features with the Mediterranean and DASH diets (29). According to Willcox et al. (2007), the consumed food groups and the concordance energy intake of the traditional Okinawan diet were as below: rice (12% of total calories), wheat, barley and other grains (7% of total calories), nuts and seeds (<1% of total calories), sugars (<1% of total calories), oils (2% of total calories), legumes (6% of total calories), fish (1% of total calories), meat (including poultry) (<1% of total calories), eggs (<1% of total calories), diary (<1% of total calories), sweet potatoes (69% of total calories), other potatoes (<1% of total calories), other vegetables (3% of total calories), fruit (<1% of total calories), seaweed (<1% of total calories), pickled vegetables (0% of total calories), flavors & alcohol (<1% of total calories). Each food group mentioned above was scored 1 if the ratio of energy intake achieved the concordance % of total calories. As we did not have the information of seaweed intake, in calculation of the Okinawan diet score, seaweed intake was not included, therefore the maximum Okinawan diet score was 16.

Anthropometric measurements

Body weight was measured to the nearest 0.1 kg with participants wearing a light gown, using the Physician Balance Beam Scale (Healthometer, Illinois, USA). Height was measured to the nearest 0.1 cm using the Holtain Harpenden stadiometer (Holtain Ltd, Crosswell, UK). Body mass index (BMI) was calculated as body weight in kg / (height in m)^2.

Laboratory measurements

Fasting serum samples were collected at baseline and stored at -80°C. Levels of 25-hydroxyvitamin D (25OHD) and hsCRP were measured by using liquid chromatography–mass spectrometry methods and a commercially available enzyme-linked immunosorbent assay respectively. Both assays were performed by PathLab Co. Ltd.

Mortality ascertainment and follow up period

Mortality data were ascertained from the Hong Kong Government Death Registry. Causes of death were coded according to the 10th revision of the International Classification of Diseases (ICD-10). Data on all-cause mortality and CVD mortality (ICD-10 codes: I00-I99) were generated. The follow up period was defined as the time from the baseline examination to the date of death or the date to the latest database update (i.e. 30 March 2017), whichever came first.

Table 1
Baseline characteristics by dietary pattern scores in men (n=1,406)

Parameters	DQI-I					DASH					MIND					MDS				
	Q1 (n=446)		Q3 (n=512)			Low (n=994)		High (n=412)			Q1 (n=571)		Q3 (n=326)			Low (n=468)		High (n=259)		
	mean/n	SD/%	mean/n	SD/%	p trend*	mean/n	SD/%	mean/n	SD/%	p trend*	mean/n	SD/%	mean/n	SD/%	p trend*	mean/n	SD/%	mean/n	SD/%	p trend*
Age (years)	72.5	5.1	72.6	5.2	0.772	72.6	5.2	72.5	5.1	0.907	73.1	5.3	72.1	4.9	0.006	72.7	5.5	72.3	5.1	0.643
Body mass index (BMI) (kg/m2)	23.7	3.4	23.5	2.8	0.237	23.6	3.2	23.5	3.0	0.706	23.3	3.3	23.8	2.9	0.015	23.4	3.2	24.1	3.1	0.003
PASE total score	87.5	47.5	99.7	47.7	<0.001	95.1	49.0	94.7	47.6	0.890	89.3	47.5	98.8	44.4	0.005	90.7	49.8	99.9	47.7	0.014
Energy intake (kcal/d)	2010.1	670.2	2199.3	547	<0.001	2125.4	615.2	2036.6	537.4	0.011	1977.4	558.9	2261.2	604.7	<0.001	1896.9	541.1	2311.8	577.8	<0.001
hsCRP (mg/L) **	1.9 (0.9 to 3.7)		1.4 (0.7 to 2.8)		<0.001	1.6 (0.8 to 3.3)		1.5 (0.7 to 3.0)		0.116	1.7 (0.9 to 3.6)		1.5 (0.7 to 2.8)		0.021	1.7 (0.8 to 3.5)		1.4 (0.7 to 2.9)		0.217
Serum 25OHD (nmol/L)	62.9	16.1	63.8	15.0	0.374	63.2	15.7	63.7	15.5	0.612	62.8	14.6	63.0	16.4	0.839	62.0	15.7	64.6	15.3	0.033
Blood taking season (%)					0.596					0.719					0.976					0.005
Spring	61	13.7%	90	17.6%		138	13.9%	71	17.2%		89	15.6%	41	12.6%		66	14.1%	54	20.8%	
Summer	103	23.1%	100	19.5%		223	22.4%	81	19.7%		118	20.7%	86	26.4%		93	19.9%	56	21.6%	
Autumn	142	31.8%	157	30.7%		322	32.4%	124	30.1%		176	30.8%	92	28.2%		140	29.9%	77	29.7%	
Winter	140	31.4%	165	32.2%		311	31.3%	136	33.0%		188	32.9%	107	32.8%		169	36.1%	72	27.8%	
Current smoker (%)	82	18.4%	43	8.4%	<0.001	130	13.1%	33	8.0%	0.007	82	14.4%	29	8.9%	0.009	66	14.1%	22	8.5%	0.019
Current drinker (%)	110	24.7%	103	20.1%	0.088	247	24.9%	77	18.7%	0.013	74	13.0%	115	35.3%	<0.001	98	20.9%	65	25.1%	0.172
Education level (%)					0.003					0.013					<0.001					0.031
Primary school or below	302	67.7%	299	58.4%		637	64.1%	235	57.0%		391	68.5%	160	49.1%		282	60.3%	180	69.5%	
Secondary school or above	144	32.3%	213	41.6%		357	35.9%	177	43.0%		180	31.5%	166	50.9%		186	39.7%	79	30.5%	
Living alone (%)	24	5.4%	18	3.5%	0.162	19	4.6%	45	4.5%	0.945	28	4.9%	8	2.5%	0.147	28	6.0%	11	4.3%	0.174
Self-reported of HT history (%)	195	43.7%	204	39.8%	0.227	406	40.9%	178	43.2%	0.414	236	41.3%	141	43.3%	0.639	194	41.5%	100	38.6%	0.580
Self-reported of DM history (%)	71	15.9%	66	12.9%	0.186	128	12.9%	66	16.0%	0.120	73	12.8%	57	17.5%	0.077	66	14.1%	30	11.6%	0.431
Self-reported of CVD events (%)	89	20.0%	114	22.3%	0.402	211	21.2%	94	22.8%	0.511	123	21.5%	74	22.7%	0.731	98	20.9%	63	24.3%	0.342
Married (%)	383	85.9%	459	89.7%	0.074	867	87.2%	366	88.8%	0.403	485	84.9%	301	92.3%	0.001	404	86.3%	238	91.9%	0.046
All-cause death (%)	202	45.3%	202	39.5%	0.069	427	43.0%	165	40.1%	0.315	264	46.2%	119	36.5%	0.004	212	45.3%	108	41.7%	0.219
CVD death (%)	38	13.7%	47	13.2%	0.835	90	13.9%	39	13.7%	0.949	56	15.6%	34	14.2%	0.508	44	14.8%	28	15.8%	0.934
CSID (%)					0.063					0.452					0.114					0.203
Normal (CSID≥29.5)	381	85.4%	456	89.1%		865	87.0%	366	88.8%		491	86.0%	289	88.7%		418	89.3%	226	87.3%	
Borderline (CSID: 28.4 - 29.49)	35	7.9%	34	6.6%		77	7.8%	26	6.3%		43	7.5%	23	7.1%		29	6.2%	15	5.8%	
Probably dementia (CSID <28.4)	30	6.7%	22	4.3%		52	5.2%	20	4.9%		37	6.5%	14	4.3%		21	4.5%	18	7.0%	
GDS (>=8) (%)	45	10.1%	33	6.5%	0.038	29	7.0%	80	8.1%	0.520	55	9.6%	22	6.8%	0.073	32	6.8%	21	8.1%	0.461

Table 1

Baseline characteristics by dietary pattern scores in men (n=1,406) (cont')

Parameters	Okinawan Score					Factor 1: Vegetables-fruits					Factor 2: Snacks-drinks-milk products					Factor 3: Meat-fish				
	Q1 (n=454)		Q3 (n=582)			Q1 (n=468)		Q3 (n=471)			Q1 (n=467)		Q3 (n=470)			Q1 (n=467)		Q3 (n=471)		
	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*
Age (years)	73.0	5.1	72.3	5.2	0.034	72.3	5.0	72.7	5.2	0.246	73.0	4.9	72.1	5.4	0.012	72.4	4.9	72.7	5.3	0.366
Body mass index (BMI) (kg/m2)	23.5	3.4	23.5	2.9	0.986	23.4	3.3	23.8	3	0.040	23.7	3.2	23.5	3.2	0.201	23.4	3	23.8	3.3	0.096
PASE total score	91	45.9	98.5	49.4	0.013	91.2	48.1	98.5	52.2	0.020	95	48.6	97.6	50.6	0.400	95.2	47.3	96	51.2	0.823
Energy intake (kcal/d)	2021.1	569.4	2137.9	593.1	0.002	2046	570.7	2144.1	636.1	0.011	1957.6	544.8	2258.4	622	<0.001	2003.8	554.8	2196.1	646.1	<0.001
hsCRP (mg/L) **	1.7 (0.9 to 3.2)		1.4 (0.7 to 2.8)		0.005	1.8 (0.9 to 3.7)		1.5 (0.7 to 2.9)		0.002	1.8 (0.9 to 3.5)		1.4 (0.7 to 2.8)		0.002	1.5 (0.7 to 3.1)		1.7 (0.8 to 3.6)		0.008
Serum 25OHD (nmol/L)	63.3	15.7	62.5	15.7	0.385	63.4	15.0	63.0	14.9	0.723	65.1	16.3	61.9	15.2	0.001	62.9	16.1	63.9	16.2	0.347
Blood taking season (%)					0.633					0.048					0.094					0.011
Spring	68	15.0%	85	14.6%		50	10.7%	78	16.6%		77	16.5%	64	13.6%		64	13.7%	67	14.2%	
Summer	84	18.5%	129	22.2%		102	21.8%	93	19.7%		110	23.6%	98	20.9%		97	20.8%	112	23.8%	
Autumn	152	33.5%	180	30.9%		153	32.7%	154	32.7%		140	30.0%	153	32.6%		125	26.8%	172	36.5%	
Winter	150	33.0%	188	32.3%		163	34.8%	146	31.0%		140	30.0%	155	33.0%		181	38.8%	120	25.5%	
Current smoker (%)	57	12.6%	63	10.8%	0.388	81	17.3%	31	6.6%	<0.001	50	10.7%	59	12.6%	0.378	43	9.2%	62	13.2%	0.059
Current drinker (%)	68	15.0%	168	28.9%	<0.001	113	24.2%	86	18.3%	0.032	77	16.5%	133	28.3%	<0.001	79	16.9%	139	29.5%	<0.001
Education level (%)					<0.001					<0.001					<0.001					0.003
Primary school or below	341	75.1%	296	50.9%		326	69.7%	264	56.1%		351	75.2%	217	46.2%		260	55.7%	306	65.0%	
Secondary school or above	113	24.9%	286	49.1%		142	30.3%	207	44.0%		116	24.8%	253	53.8%		207	44.3%	165	35.0%	
Living alone (%)	22	4.9%	25	4.3%	0.672	22	4.7%	15	3.2%	0.264	22	4.7%	24	5.1%	0.770	30	6.4%	15	3.2%	0.017
Self-reported of HT history (%)	182	40.1%	236	40.6%	0.958	178	38.0%	200	42.5%	0.169	212	45.4%	175	37.2%	0.011	176	37.7%	201	42.7%	0.122
Self-reported of DM history (%)	47	10.4%	89	15.3%	0.028	59	12.6%	71	15.1%	0.273	69	14.8%	59	12.6%	0.324	48	10.3%	76	16.1%	0.009
Self-reported of CVD events (%)	111	24.5%	120	20.6%	0.155	94	20.1%	114	24.2%	0.126	108	23.1%	88	18.7%	0.102	104	22.3%	91	19.3%	0.272
Married (%)	395	87.0%	517	88.8%	0.354	412	88.0%	416	88.3%	0.892	415	88.9%	414	88.1%	0.718	418	89.5%	408	86.6%	0.180
All-cause death (%)	211	46.5%	241	41.4%	0.131	216	46.2%	190	40.3%	0.072	214	45.8%	191	40.6%	0.109	194	41.5%	196	41.6%	0.983
CVD death (%)	39	14.1%	57	14.4%	0.851	40	13.8%	42	13.2%	0.826	53	17.6%	38	12.1%	0.048	42	13.5%	45	14.2%	0.778
CSID (%)					0.109					0.375					0.045					0.143
Normal (CSID≥29.5)	391	86.1%	515	88.5%		406	86.8%	416	88.3%		402	86.1%	423	90.0%		419	89.7%	408	86.6%	
Borderline (CSID: 28.4 - 29.49)	30	6.6%	41	7.0%		32	6.8%	31	6.6%		37	7.9%	31	6.6%		25	5.4%	32	6.8%	
Probably dementia (CSID <28.4)	33	7.3%	26	4.5%		30	6.4%	24	5.1%		28	6.0%	16	3.4%		23	4.9%	31	6.6%	
GDS (>=8) (%)	48	10.6%	31	5.3%	0.002	40	8.6%	33	7.0%	0.378	49	10.5%	24	5.1%	0.002	34	7.3%	37	7.9%	0.741

*Linear trend test by Chi-square test (categorical variables) or one way ANOVA test (continuous variables) where appropriate. **: median (interquarter range)

Statistical analysis

Statistical analyses were performed separately for men and women using the statistical package SPSS version 24 (SPSS Inc., Illinois, US). The three dietary pattern scores derived by the factor analysis, the DQI-I total score, the MIND score, the Okinawan diet score were stratified into tertiles based on the distribution of each sex. The MDS was divided into three levels of adherence, namely low (0-3), medium (4-5) and high (≥6) (Trichopoulou A 2003, Osler M 1997). The DASH score was divided into two levels of accordance, using a total DASH score of at least 4.5 as a cutoff value (27). Serum vitamin D level was stratified into quintiles based on the distribution of each sex. The differences in baseline characteristics, laboratory parameters, dietary pattern scores and mortality across tertiles or categories of each dietary pattern score in men and women were examined using chi square test for categorical variables and by one way ANOVA test for continuous variables, where appropriate.

The Cox proportional hazards model was used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for all-cause or CVD mortality during the follow up period according to tertiles of each dietary pattern score or three levels of MDS or the DASH accordance. Model 1 was unadjusted model. Model 2 was adjusted for baseline age (years), BMI (kg/m^2), current smoker, current alcohol use, PASE and daily energy intake (kcal). Model 3 was further adjusted for education level, self-reported history of hypertension, diabetes and heart diseases. Model 4 was additionally adjusted for season of blood collection, serum levels of 25OHD (nmol/L) and hsCRP (mg/L) (logarithmic transformed), being married, living alone, having depressive symptoms, CSID categories. Test for trend was examined by entering tertiles of each dietary pattern score or three levels of MDS or the DASH accordance as a continuous variable in all models. An α level of 5%, 2 sided was considered as statistically significant.

Results

Participants' characteristics by each dietary pattern

There were 955 (592 men and 363 women) all-cause deaths and 230 (101 men and 129 women) CVD deaths during a mean follow up of 12.4±3.5 years (men: 12.0±4.0 and women 12.7±2.8). Mean age of the participants was 73 years and 50.2% of the participants were men.

Baseline characteristics of men and women according to each dietary pattern score are shown in Tables 1 and 2 respectively. In men, there were significant differences in lifestyle profiles and demographic characteristics across tertiles or categories of the dietary pattern scores. Higher tertile of DQI-I score, MIND score, Okinawan diet score and "vegetables-fruits" dietary pattern score as well as higher adherence to the Mediterranean diet were associated with higher PASE score. All dietary pattern scores except DASH score were positively associated with daily energy intake. Higher tertile or adherence to the majority of the dietary pattern scores were associated with lower proportion of current smoker but higher education attainment. hsCRP level was in general inversely associated with DQI-I score, MIND score, Okinawan diet score, "vegetables-fruits" dietary pattern, and "snacks-drinks-milk" dietary pattern, while higher "meat-fish" dietary pattern was associated with higher hsCRP level. There was no association between serum 25OHD and dietary patterns except for MDS and "snacks-drinks-milk" dietary pattern. Higher serum 25OHD level was associated with higher adherence to MDS but lower "snacks-drinks-milk" dietary pattern score (Table 1).

In women, higher tertile of DQI-I score, MIND score and "vegetables-fruits" dietary pattern were associated with higher PASE score, whereas higher tertile of "meat-fish" dietary pattern score was associated with lower PASE score. Higher tertile of DQI-I score, higher Okinawan diet score, higher MIND score, higher adherence to MDS, higher "vegetables-fruits", "snacks-drinks-milk" and "meat-fish" dietary pattern scores were associated with higher daily energy intake. Higher tertile of the DQI-I score, MIND score, and "vegetables-fruits" dietary pattern as well as higher adherence to the Mediterranean diet were associated with lower proportion of current smoker. Most dietary pattern scores were positively associated with higher education attainment. hsCRP level and serum 25OHD level were not associated with any dietary patterns in women (Table 2).

Dietary patterns and mortality

In men, higher DQI-I score, MIND score, Okinawan diet score, "vegetable-fruits" dietary pattern score, as well as "snacks-drinks-milk products" dietary pattern score were significantly associated with lower risk of all-cause mortality in the unadjusted model (p-trend all <0.05). However, the associations were no longer significant after adjustment for the demographic variables and lifestyle risk factors, and further adjustment for serum levels of hsCRP and serum 25OHD as well as other psychological parameters did not change the results (Table 3). In women, higher DQI-I score, MIND score, Okinawan diet score, and "snacks-drinks-milk products" dietary pattern score were significantly associated with lower risk of all-cause mortality in the unadjusted model (p-trend all <0.05). The associations remained significant only for the DQI-I score and the Okinawan diet score in the multivariate adjusted models. Adjustment for a model with serum levels of hsCRP and 25OHD as well as other psychological parameters did not change the results. Highest tertile of the DQI-I score and the Okinawan diet score was associated with 23% and 22% respectively reduction in the risk of all-cause mortality in comparison to the lowest tertile (p-trend = 0.038 for the DQI-I total score and 0.046 for the Okinawan diet score) (Table 4).

In men, none of the dietary pattern scores showed significant association with CVD mortality in both unadjusted and multivariate adjusted models (Table 5). In women, higher

Table 2

Baseline characteristics by dietary pattern scores in women (n=1,396)

Parameters	DQI-I					DASH					MIND					MDS				
	Q1 (n=466)		Q3 (n=464)			Low (n=694)		High (n=702)			Q1 (n=468)		Q3 (n=365)			Q1 (n=518)		Q3 (n=251)		
	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*
Age (years)	72.8	5.7	72.2	5.2	0.066	72.8	5.5	72.4	5.3	0.136	73.1	5.7	71.8	5.1	0.001	72.7	5.5	72.3	5.1	0.329
Body mass index (BMI) (kg/m2)	23.8	3.6	23.7	3.1	0.893	24.0	3.5	23.8	3.3	0.496	24	3.4	23.6	3.5	0.078	23.9	3.3	23.9	3.3	0.908
PASE total score	81.7	31.8	89.5	33.6	<0.001	84.4	33.6	86.5	33.1	0.227	81	31.4	89.7	34.2	<0.001	84.2	37.1	88.5	32.4	0.092
Energy intake (kcal/d)	1422.2	500.1	1755.7	412.7	<0.001	1610.2	484.7	1545.7	440.1	0.009	1452.1	452.7	1731.4	459.2	<0.001	1429.8	410.1	1786.5	448.1	<0.001
hsCRP (mg/L)**	1.9 (0.9 to 4.3)		1.7 (0.9 to 3.5)		0.249	1.9 (0.8 to 4.3)		1.8 (0.9 to 3.5)		0.463	2.0 (0.9 to 4.3)		1.8 (0.8 to 3.8)		0.195	1.9 (0.9 to 3.8)		1.8 (0.9 to 3.7)		0.538
Serum 25OHD (nmol/L)	57.5	14.8	58.0	14.4	0.590	57.3	14.8	58.1	14.5	0.292	57.5	14.6	58.1	14.3	0.521	56.9	14.6	58.4	14.9	0.173
Blood taking season (%)					0.563					0.526					0.019					0.141
Spring	104	22.3%	80	17.2%		154	22.2%	126	17.9%		94	20.1%	80	21.9%		113	21.8%	52	20.7%	
Summer	110	23.6%	157	33.8%		166	23.9%	214	30.5%		105	22.4%	121	33.2%		109	21.0%	84	33.5%	
Autumn	154	33.0%	147	31.7%		221	31.8%	245	34.9%		175	37.4%	101	27.7%		193	37.3%	71	28.3%	
Winter	98	21.0%	80	17.2%		153	22.0%	117	16.7%		94	20.1%	63	17.3%		103	19.9%	44	17.5%	
Current smoker (%)	15	3.2%	2	0.4%	0.002	10	1.4%	16	2.3%	0.224	13	2.8%	3	0.8%	0.038	13	2.5%	0	0.0%	0.027
Current drinker (%)	15	3.2%	15	3.2%	0.991	20	2.9%	18	2.6%	0.715	8	1.7%	13	3.6%	0.095	13	2.5%	8	3.2%	0.603
Education level (%)					<0.001					0.019					0.001					0.743
Primary school or below	402	86.3%	360	77.6%		582	83.9%	570	81.2%		404	86.3%	284	77.8%		422	81.5%	205	81.7%	
Secondary school or above	64	13.7%	104	22.4%		112	16.1%	132	18.8%		64	13.7%	81	22.2%		96	18.5%	46	18.3%	
Living alone (%)	73	15.7%	102	22.0%	0.013	94	13.5%	162	23.1%	<0.001	91	19.4%	57	15.6%	0.174	95	18.3%	49	19.5%	0.775
Self-reported of HT history (%)	204	43.8%	195	42.0%	0.589	292	42.1%	305	43.5%	0.604	206	44.0%	155	42.5%	0.625	220	42.5%	108	43.0%	0.869
Self-reported of DM history (%)	80	17.2%	61	13.2%	0.080	95	13.7%	105	15.0%	0.499	66	14.1%	58	15.9%	0.502	69	13.3%	30	12.0%	0.937
Self-reported of CVD events (%)	96	20.6%	79	17.0%	0.153	130	18.7%	117	16.7%	0.312	84	18.0%	69	18.9%	0.769	95	18.3%	42	16.7%	0.573
Married (%)	247	53.0%	241	51.9%	0.745	396	57.1%	332	47.3%	<0.001	225	48.1%	206	56.4%	0.016	263	50.8%	132	52.6%	0.538
All-cause death (%)	147	31.6%	106	22.8%	0.002	194	28.0%	169	24.1%	0.099	144	30.8%	81	22.2%	0.004	141	27.2%	58	23.1%	0.248
CVD death (%)	44	12.2%	28	7.3%	0.021	54	8%	46	8.0%	0.284	49	13.2%	19	6.3%	0.001	40	9.6%	14	6.8%	0.283
CSID (%)					<0.001					0.009					<0.001					0.251
Normal (CSID≥29.5)	242	51.9%	306	66.0%		394	56.8%	443	63.1%		245	52.4%	242	66.3%		298	57.5%	153	61.0%	
Borderline (CSID: 28.4 - 29.49)	83	17.8%	68	14.7%		112	16.1%	107	15.2%		76	16.2%	52	14.3%		86	16.6%	40	15.9%	
Probably dementia (CSID <28.4)	141	30.3%	90	19.4%		188	27.1%	152	21.7%		147	31.4%	71	19.5%		134	25.9%	58	23.1%	
GDS (>=8) (%)	52	11.2%	34	7.3%	0.043	73	10.5%	55	7.8%	0.082	64	13.7%	24	6.6%	<0.001	59	11.4%	16	6.4%	0.017

Table 2
Baseline characteristics by dietary pattern scores in women (n=1,396) (con't)

Parameters	Okinawan Score					Factor 1: Vegetables-fruits					Factor 2: Snacks-drinks-milk products					Factor 3: Meat-fish				
	Q1 (n=456)		Q3 (n=510)			Q1 (n=464)		Q3 (n=466)			Q1 (n=1)		Q3 (n=465)			Q1 (n=1)		Q3 (n=464)		
	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*	mean/n	SD/%	mean/n	SD/%	p-trend*
Age (years)	72.7	5.4	72.3	5.5	0.293	73.2	5.5	72.1	5.3	0.002	72.7	5.1	72.1	5.7	0.096	72.6	5.6	72.7	5.5	0.990
Body mass index (BMI) (kg/m2)	24	3.3	23.8	3.5	0.367	23.9	3.4	23.9	3.4	0.852	24.2	3.5	23.8	3.5	0.137	23.4	3.4	24.2	3.4	<0.001
PASE total score	84.5	32.1	88	35.3	0.102	82.9	32.4	87.6	34.2	0.034	85.6	29.9	87.1	36.1	0.496	87.5	33.1	83.2	32.7	0.049
Energy intake (kcal/d)	1509.9	470.7	1639.9	474.5	<0.001	1503.7	426.9	1660.1	525.6	<0.001	1441.1	403.4	1737.9	509.7	<0.001	1477.9	403.2	1681.1	521.6	<0.001
hsCRP (mg/L) **	2.0 (0.9 to 3.8)		1.7 (0.8 to 3.9)		0.556	1.8 (0.9 to 3.8)		1.8 (0.9 to 3.6)		0.530	2.0 (0.9 to 4.1)		1.8 (0.8 to 3.7)		0.429	1.8 (0.8 to 3.7)		1.9 (0.9 to 3.8)		0.535
Serum 25OHD (nmol/L)	57.9	14.8	57.5	14.4	0.677	57.1	15.2	57.4	14.1	0.728	57.9	14.8	56.8	14.9	0.249	57.1	14.4	58.1	14.5	0.284
Blood taking season (%)					0.703					0.749					0.489					0.432
Spring	92	20.2%	93	18.2%		110	23.7%	86	18.5%		85	18.3%	104	22.3%		84	18.1%	89	19.1%	
Summer	103	22.6%	154	30.2%		106	22.8%	149	32.0%		134	28.8%	123	26.4%		138	29.7%	121	25.9%	
Autumn	174	38.2%	161	31.6%		163	35.1%	142	30.5%		154	33.1%	142	30.5%		155	33.4%	154	33.0%	
Winter	87	19.1%	102	20.0%		85	18.3%	89	19.1%		92	19.8%	97	20.8%		87	18.8%	103	22.1%	
Current smoker (%)	9	2.0%	9	1.8%	0.811	16	3.5%	5	1.1%	0.007	8	1.7%	14	3.0%	0.147	10	2.2%	11	2.4%	0.819
Current drinker (%)	8	1.8%	16	3.1%	0.196	11	2.4%	16	3.4%	0.319	5	1.1%	15	3.2%	0.045	11	2.4%	19	4.1%	0.111
Education level (%)					<0.001					<0.001					<0.001					0.899
Primary school or below	406	89.0%	380	74.5%		410	88.4%	359	77.0%		437	94.0%	326	70.0%		383	82.5%	384	82.2%	
Secondary school or above	50	11.0%	130	25.5%		54	11.6%	107	23.0%		28	6.0%	140	30.0%		81	17.5%	83	17.8%	
Living alone (%)	100	21.9%	79	15.5%	0.001	96	20.7%	76	16.3%	0.084	107	23.0%	73	15.7%	0.004	118	25.4%	65	13.9%	<0.001
Self-reported of HT history (%)	206	45.2%	201	39.4%	0.068	196	42.2%	202	43.4%	0.733	214	46.0%	184	39.5%	0.044	193	41.6%	209	44.8%	0.330
Self-reported of DM history (%)	71	15.6%	53	10.4%	0.018	67	14.4%	68	14.6%	0.947	79	17.0%	44	9.4%	0.001	57	12.3%	73	15.6%	0.145
Self-reported of CVD events (%)	85	18.6%	102	20.0%	0.530	85	18.3%	87	18.7%	0.887	91	19.6%	73	15.7%	0.119	81	17.5%	101	21.6%	0.095
Married (%)	218	47.8%	283	55.5%	0.018	225	48.5%	260	55.8%	0.026	232	49.9%	262	56.2%	0.053	201	43.3%	285	61.0%	<0.001
All-cause death (%)	143	31.4%	118	23.1%	0.004	132	28.5%	111	23.8%	0.108	120	25.8%	94	20.2%	0.050	126	27.2%	121	25.9%	0.666
CVD death (%)	47	13.1%	32	7.6%	0.010	39	10.6%	23	6.1%	0.032	37	9.7%	24	6.1%	0.072	35	9.4%	36	9.5%	0.979
CSID (%)					<0.001					<0.001					<0.001					0.998
Normal (CSID≥29.5)	243	53.3%	347	68.0%		244	52.6%	319	68.5%		219	47.1%	343	73.6%		283	61.0%	286	61.2%	
Borderline (CSID: 28.4 - 29.49)	75	16.5%	62	12.2%		83	17.9%	54	11.6%		98	21.1%	49	10.5%		66	14.2%	64	13.7%	
Probably dementia (CSID <28.4)	138	30.3%	101	19.8%		137	29.5%	93	20.0%		148	31.8%	74	15.9%		115	24.8%	117	25.1%	
GDS (>=8) (%)	53	11.6%	35	6.9%	0.001	64	13.8%	29	6.2%	<0.001	50	10.8%	37	7.9%	0.137	46	9.9%	38	8.1%	0.348

*Linear trend test by Chi-square test (categorical variables) or one way ANOVA test (continuous variables) where appropriate. ** median (interquarter range)

Table 3
All cause death and diet factors (Men)*†

Men (n=1,406)	Alive		All-cause death		HR (95% CI)			
Diet pattern	**(n)**	**(%)**	**(n)**	**(%)**	**Model 1 - crude**	**Model 2**	**Model 3**	**Model 4**
DQI-I score								
Q1	244	54.71%	202	45.29%	reference	reference	reference	reference
Q2	260	58.04%	188	41.96%	0.87 (0.71,1.06)	0.89 (0.73,1.09)	0.9 (0.74,1.10)	0.93 (0.76,1.14)
Q3	310	60.55%	202	39.45%	0.80 (0.66,0.97)	0.81 (0.66,0.99)	0.83 (0.68,1.01)	0.9 (0.73,1.10)
P-trend					0.024	0.037	0.062	0.291
DASH score								
High (≥5)	247	59.95%	165	40.05%	reference	reference	reference	reference
Low (≤4)	567	57.04%	427	42.96%	1.11 (0.93,1.33)	1.15 (0.96,1.38)	1.14 (0.95,1.37)	1.11 (0.92,1.33)
MIND score								
Q1	307	53.77%	264	46.23%	reference	reference	reference	reference
Q2	300	58.94%	209	41.06%	0.82 (0.68,0.98)	0.91 (0.75,1.09)	0.90 (0.75,1.08)	0.95 (0.78,1.14)
Q3	207	63.5%	119	36.5%	0.70 (0.56,0.87)	0.81 (0.64,1.01)	0.81 (0.65,1.02)	0.85 (0.67,1.07)
P-trend					0.001	0.059	0.068	0.173
MDS								
0-3	256	54.7%	212	45.3%	reference	reference	reference	reference
4-5	407	59.94%	272	40.06%	0.84 (0.7,1.003)	0.85 (0.71,1.02)	0.84 (0.7,1.01)	0.86 (0.71,1.03)
6-9	151	58.3%	108	41.7%	0.86 (0.68,1.09)	0.94 (0.74,1.19)	0.92 (0.72,1.17)	0.96 (0.75,1.22)
P-trend					0.122	0.369	0.306	0.477
Okinawan diet score								
Q1	243	53.52%	211	46.48%	reference	reference	reference	reference
Q2	230	62.16%	140	37.84%	0.75 (0.61,0.93)	0.80 (0.65,0.99)	0.80 (0.64,0.995)	0.81 (0.65,1.01)
Q3	341	58.59%	241	41.41%	0.82 (0.68,0.99)	0.90 (0.75,1.09)	0.94 (0.77,1.14)	0.95 (0.78,1.16)
P-trend					0.045	0.318	0.565	0.698
Hong Kong diet pattern								
Factor 1: vegetables–fruits								
Q1	252	53.85%	216	46.15%	reference	reference	reference	reference
Q2	281	60.17%	186	39.83%	0.81 (0.67,0.98)	0.80 (0.66,0.98)	0.80 (0.66,0.98)	0.82 (0.67,1.001)
Q3	281	59.66%	190	40.34%	0.82 (0.67,0.996)	0.83 (0.68,1.01)	0.83 (0.68,1.02)	0.86 (0.7,1.05)
P-trend					0.044	0.058	0.070	0.122
Factor 2: snacks–drinks–milk products								
Q1	253	54.18%	214	45.82%	reference	reference	reference	reference
Q2	281	60.04%	187	39.96%	0.82 (0.68,1.002)	0.81 (0.67,0.99)	0.83 (0.68,1.01)	0.82 (0.67,1.002)
Q3	279	59.36%	191	40.64%	0.82 (0.67,0.99)	0.89 (0.73,1.09)	0.97 (0.78,1.19)	0.98 (0.79,1.20)
P-trend					0.042	0.25	0.669	0.793
Factor 3: meat-fish								
Q1	273	58.46%	194	41.54%	reference	reference	reference	reference
Q2	266	56.96%	201	43.04%	1.06 (0.87,1.29)	1.04 (0.85,1.27)	0.97 (0.79,1.19)	0.93 (0.76,1.14)
Q3	275	58.39%	196	41.61%	1.001 (0.82,1.22)	0.999 (0.82,1.22)	0.95 (0.77,1.16)	0.87 (0.7,1.07)
P-trend					0.997	0.998	0.585	0.172

*excluded daily energy intake <500kcal or ≥5000 kcal; † death record obtained from Death Registry only; Model 2 – adjusted for age, BMI, smoking, drinking, PASE score and daily energy intake; Model 3 – adjusted for model 2 and further adjusted for education level, medical history of HT, DM and heart disease; Model 4 – adjusted model 3 and further adjusted serum 25OHD level, season of blood taking, log hsCRP, marital status, living alone, GDS category (normal or depressed), CSID category (normal, borderline or possibly dementia)

DQI-I total score, MIND score, Okinawan diet score, and "vegetables-fruits" dietary pattern score, were significantly associated with lower risk of CVD mortality in the unadjusted model (p-trend all <0.05). The significant association only remained for the MIND score in the multivariate adjusted model and further adjustment of serum levels of hsCRP and 25OHD as well as other psychological parameters did not change the results (Table 6).

Table 4
All cause death and diet factors (Women)*†

Women (n=1,396)					**HR (95% CI)**			
Diet pattern	**Alive (n)**	**(%)**	**All-cause death (n)**	**(%)**	**Model 1 - crude**	**Model 2**	**Model 3**	**Model 4**
DQI-I score								
Q1	319	68.45%	147	31.55%	reference	reference	reference	reference
Q2	356	76.39%	110	23.61%	0.71 (0.56,0.91)	0.72 (0.56,0.92)	0.75 (0.58,0.96)	0.74 (0.58,0.96)
Q3	358	77.16%	106	22.84%	0.68 (0.53,0.88)	0.75 (0.58,0.98)	0.77 (0.59,1.003)	0.77 (0.59,0.998)
P-trend					0.002	0.026	0.042	0.038
DASH score								
High (≥5)	533	75.93%	169	24.07%	reference	reference	reference	reference
Low (≤4)	500	72.05%	194	27.95%	1.18 (0.96,1.45)	1.17 (0.95,1.43)	1.17 (0.95,1.44)	1.18 (0.95,1.45)
MIND score								
Q1	324	69.23%	144	30.77%	reference	reference	reference	reference
Q2	425	75.49%	138	24.51%	0.77 (0.61,0.98)	0.86 (0.68,1.09)	0.84 (0.67,1.07)	0.88 (0.69,1.11)
Q3	284	77.81%	81	22.19%	0.68 (0.51,0.89)	0.83 (0.63,1.11)	0.81 (0.61,1.07)	0.84 (0.63,1.12)
P-trend					0.003	0.166	0.109	0.195
MDS								
0-3	377	72.78%	141	27.22%	reference	reference	reference	reference
4-5	463	73.84%	164	26.16%	0.95 (0.76,1.19)	0.96 (0.76,1.2)	0.94 (0.75,1.19)	0.97 (0.77,1.22)
6-9	193	76.89%	58	23.11%	0.81 (0.60,1.11)	0.88 (0.64,1.21)	0.87 (0.63,1.19)	0.89 (0.65,1.22)
P-trend					0.213	0.447	0.337	0.484
Okinawan diet score								
Q1	313	68.64%	143	31.36%	reference	reference	reference	reference
Q2	328	76.28%	102	23.72%	0.72 (0.56,0.92)	0.70 (0.54,0.91)	0.71 (0.55,0.92)	0.72 (0.56,0.93)
Q3	392	76.86%	118	23.14%	0.70 (0.55,0.90)	0.74 (0.58,0.95)	0.76 (0.6,0.98)	0.78 (0.61,1.002)
P-trend					0.004	0.015	0.030	0.046
Hong Kong diet pattern								
Factor 1: vegetables–fruits								
Q1	332	71.55%	132	28.45%	reference	reference	reference	reference
Q2	346	74.41%	119	25.59%	0.88 (0.69,1.13)	0.96 (0.75,1.23)	0.966 (0.78,1.28)	1.04 (0.81,1.35)
Q3	355	76.18%	111	23.82%	0.81 (0.63,1.04)	0.98 (0.76,1.27)	1.007 (0.78,1.30)	1.04 (0.80,1.36)
P-trend					0.108	0.857	0.940	0.741
Factor 2: snacks–drinks–milk products								
Q1	345	74.19%	120	25.81%	reference	reference	reference	reference
Q2	316	67.96%	149	32.04%	1.27 (0.996,1.61)	1.23 (0.96,1.57)	1.24 (0.97,1.59)	1.25 (0.97,1.6)
Q3	372	79.83%	94	20.17%	0.74 (0.56,0.97)	0.79 (0.60,1.04)	0.84 (0.63,1.12)	0.83 (0.62,1.11)
P-trend					0.034	0.116	0.298	0.254
Factor 3: meat-fish								
Q1	338	72.84%	126	27.16%	reference	reference	reference	reference
Q2	349	75.05%	116	24.95%	0.89 (0.70,1.15)	0.92 (0.71,1.19)	0.92 (0.71,1.19)	0.94 (0.73,1.22)
Q3	346	74.09%	121	25.91%	0.93 (0.73,1.20)	0.97 (0.75,1.26)	0.95 (0.74,1.24)	1.0002 (0.77,1.3)
P-trend					0.506	0.835	0.705	0.990

*excluded daily energy intake <500kcal or ≥5000 kcal; † death record obtained from Death Registry only; Model 2 – adjusted for age, BMI, smoking, drinking, PASE score and daily energy intake; Model 3 – adjusted for model 2 and further adjusted for education level, medical history of HT, DM and heart disease; Model 4 – adjusted for model 3 and further adjusted serum 25OHD level, season of blood taking, log hsCRP, marital status, living alone, GDS category (normal or depressed), CSID category (normal, borderline or possibly dementia)

Discussion

Our findings support that dietary patterns are associated with the mortality, independent of personal lifestyle factors and individual pro- or anti- inflammatory markers. However, such associations were only observed in women, in that higher DQI-I total score and Okinawan diet score were associated with a lower risk of all-cause mortality, whereas higher MIND score was associated with a reduced risk of CVD mortality. To our knowledge this study represents the first large scale

Table 5
CVD death and diet factors (Men)*†

Men (n=932)					**HR (95% CI)**			
Diet pattern	**Alive (n)**	**(%)**	**CVD death (n)**	**(%)**	**Model 1 - crude**	**Model 2**	**Model 3**	**Model 4**
DQI-I score								
Q1	276	87.34%	40	12.66%	reference	reference	reference	reference
Q2	265	83.6%	52	16.4%	1.33 (0.88,2.01)	1.3 (0.85,1.97)	1.3 (0.85,1.97)	1.33 (0.86,2.04)
Q3	262	87.63%	37	12.37%	0.97 (0.62,1.51)	0.82 (0.52,1.3)	0.84 (0.53,1.33)	0.92 (0.58,1.46)
P-trend					0.910	0.400	0.460	0.725
DASH score								
High (≥5)	245	86.27%	39	13.73%	reference	reference	reference	reference
Low (≤4)	558	86.11%	90	13.89%	1.01 (0.69,1.47)	1.2 (0.82,1.76)	1.21 (0.83,1.78)	1.18 (0.8,1.74)
MIND score								
Q1	303	84.4%	56	15.6%	reference	reference	reference	reference
Q2	294	88.29%	39	11.71%	0.73 (0.49,1.11)	0.89 (0.58,1.35)	0.91 (0.59,1.39)	0.99 (0.64,1.53)
Q3	206	85.83%	34	14.17%	0.89 (0.58,1.37)	1.02 (0.65,1.59)	1.02 (0.65,1.61)	1.07 (0.67,1.71)
P-trend					0.484	0.993	0.982	0.805
MDS								
0-3	253	85.19%	44	14.81%	reference	reference	reference	reference
4-5	401	87.55%	57	12.45%	0.82 (0.55,1.21)	0.81 (0.54,1.21)	0.81 (0.54,1.2)	0.84 (0.56,1.26)
6-9	149	84.18%	28	15.82%	1.06 (0.66,1.7)	0.99 (0.61,1.62)	1.04 (0.64,1.7)	1.07 (0.64,1.79)
P-trend					0.992	0.823	0.936	0.941
Okinawan diet score								
Q1	238	85.92%	39	14.08%	reference	reference	reference	reference
Q2	227	87.31%	33	12.69%	0.88 (0.55,1.39)	0.93 (0.58,1.49)	0.92 (0.57,1.48)	0.89 (0.55,1.45)
Q3	338	85.57%	57	14.43%	1.01 (0.67,1.52)	1.12 (0.74,1.7)	1.15 (0.74,1.77)	1.11 (0.71,1.72)
P-trend					0.914	0.536	0.500	0.600
Hong Kong diet pattern								
Factor 1: vegetables–fruits								
Q1	270	87.1%	40	12.9%	reference	reference	reference	reference
Q2	263	84.84%	47	15.16%	1.18 (0.78,1.8)	1.01 (0.66,1.56)	1.03 (0.67,1.58)	1.16 (0.75,1.79)
Q3	270	86.54%	42	13.46%	1.03 (0.67,1.59)	0.87 (0.56,1.34)	0.83 (0.53,1.29)	0.89 (0.56,1.39)
P-trend					0.889	0.502	0.384	0.563
Factor 2: snacks–drinks–milk products								
Q1	257	82.9%	53	17.1%	reference	reference	reference	reference
Q2	272	87.74%	38	12.26%	0.71 (0.47,1.07)	0.73 (0.48,1.12)	0.74 (0.48,1.12)	0.74 (0.48,1.14)
Q3	274	87.82%	38	12.18%	0.7 (0.46,1.06)	0.85 (0.55,1.31)	0.89 (0.58,1.38)	0.86 (0.55,1.34)
P-trend					0.280	0.400	0.525	0.436
Factor 3: meat-fish								
Q1	268	86.73%	41	13.27%	reference	reference	reference	reference
Q2	268	86.17%	43	13.83%	1.05 (0.68,1.61)	1.11 (0.72,1.71)	0.98 (0.63,1.53)	0.9 (0.58,1.41)
Q3	267	85.58%	45	14.42%	1.09 (0.71,1.67)	1.21 (0.78,1.86)	1.15 (0.74,1.79)	1.02 (0.65,1.6)
P-trend					0.668	0.397	0.552	0.903

*excluded daily energy intake <500kcal or ≥5000 kcal; Model 2 – adjusted for age, BMI, smoking, drinking, PASE score and daily energy intake; Model 3 – adjusted for model 2 and further adjusted for education level, medical history of HT, DM and heart disease; Model 4 – adjusted for model 3 and further adjusted serum 25OHD level, season of blood taking, log hsCRP, marital status, living alone, GDS category (normal or depressed), CSID category (normal, borderline or possibly dementia)

population study comparing many different dietary patterns on all-cause and CVD mortality, taking into account a wide range of confounding factors including inflammatory markers.

Many studies have been recently conducted to examine the association of dietary patterns with all-cause or CVD mortality. A higher diet quality defined using the a priori approach, such as DQI (30), MDS (31-33), DASH (12, 34-36) and Healthy Eating Index (HEI) or alternative HEI (12, 37) was in general associated with a lower risk of all-cause or CVD mortality. Studies using the a posteriori approach to generate dietary

Table 6
CVD death and diet factors (Women)*

Women (n=1127)					**HR (95% CI)**			
Diet pattern	**Alive (n)**	**(%)**	**CVD death (n)**	**(%)**	**Model 1 - crude**	**Model 2**	**Model 3**	**Model 4**
DQI-I score								
Q1	317	87.81%	44	12.19%	reference	reference	reference	reference
Q2	355	92.69%	28	7.31%	0.59 (0.37,0.95)	0.58 (0.36,0.95)	0.62 (0.38,1.002)	0.63 (0.39,1.02)
Q3	355	92.69%	28	7.31%	0.60 (0.37,0.96)	0.70 (0.42,1.15)	0.74 (0.45,1.21)	0.76 (0.46,1.28)
P-trend					0.026	0.120	0.180	0.232
DASH score								
High (≥5)	530	92.01%	46	7.99%	reference	reference	reference	reference
Low (≤4)	497	90.20%	54	9.80%	1.22 (0.82,1.81)	1.25 (0.84,1.86)	1.25 (0.84,1.87)	1.90 (1.55,2.33)
MIND score								
Q1	321	86.8%	49	13.2%	reference	reference	reference	reference
Q2	424	93.0%	32	7.0%	0.52 (0.33,0.81)	0.60 (0.39,0.94)	0.58 (0.37,0.91)	0.60 (0.38,0.94)
Q3	282	93.7%	19	6.3%	0.46 (0.27,0.77)	0.64 (0.37,1.11)	0.61 (0.35,1.05)	0.63 (0.36,1.09)
P-trend					0.001	0.048	0.030	0.045
MDS								
0-3	376	90.38%	40	9.62%	reference	reference	reference	reference
4-5	459	90.89%	46	9.11%	0.95 (0.62,1.45)	0.94 (0.61,1.45)	0.95 (0.62,1.46)	0.99 (0.64,1.53)
6-9	192	93.20%	14	6.80%	0.71 (0.39,1.31)	0.86 (0.46,1.62)	0.86 (0.46,1.61)	0.86 (0.46,1.61)
P-trend					0.314	0.643	0.636	0.683
Okinawan diet score								
Q1	312	86.91%	47	13.09%	reference	reference	reference	reference
Q2	328	93.98%	21	6.02%	0.44 (0.26,0.74)	0.43 (0.26,0.72)	0.44 (0.26,0.73)	0.44 (0.26,0.74)
Q3	387	92.36%	32	7.64%	0.57 (0.36,0.89)	0.66 (0.42,1.04)	0.70 (0.44,1.11)	0.71 (0.45,1.14)
P-trend					0.010	0.051	0.087	0.113
Hong Kong diet pattern								
Factor 1: vegetables–fruits								
Q1	329	89.40%	39	10.60%	reference	reference	reference	reference
Q2	346	90.10%	38	9.90%	0.97 (0.62,1.52)	1.09 (0.69,1.71)	1.16 (0.74,1.84)	0.44 (0.26,0.74)
Q3	352	93.87%	23	6.13%	0.57 (0.34,0.96)	0.75 (0.44,1.27)	0.8 (0.47,1.36)	0.71 (0.45,1.14)
P-trend					0.039	0.333	0.476	0.536
Factor 2: snacks–drinks–milk products								
Q1	343	90.26%	37	9.74%	reference	reference	reference	reference
Q2	314	88.95%	39	11.05%	1.07 (0.69,1.68)	1.08 (0.69,1.70)	1.13 (0.71,1.79)	1.12 (0.70,1.79)
Q3	370	93.91%	24	6.09%	0.59 (0.35,0.998)	0.70 (0.41,1.21)	0.79 (0.45,1.37)	0.77 (0.44,1.34)
P-trend					0.058	0.235	0.460	0.409
Factor 3: meat-fish								
Q1	337	90.59%	35	9.41%	reference	reference	reference	reference
Q2	345	92.25%	29	7.75%	0.80 (0.49,1.32)	0.80 (0.48,1.3)	0.77 (0.47,1.27)	0.77 (0.46,1.27)
Q3	345	90.55%	36	9.45%	1.004 (0.63,1.60)	1.09 (0.67,1.76)	1.03 (0.63,1.68)	1.04 (0.63,1.71)
P-trend					0.981	0.742	0.920	0.880

*excluded daily energy intake <500kcal or ≥5000 kcal; Model 2 – adjusted for age, BMI, smoking, drinking, PASE score and daily energy intake; Model 3 – adjusted for model 2 and further adjusted for education level, medical history of HT, DM and heart disease; Model 4 – adjusted for model 3 and further adjusted serum 25OHD level, season of blood taking, log hsCRP, marital status, living alone, GDS category (normal or depressed), CSID category (normal, borderline or possibly dementia)

patterns mostly suggested that a Western dietary pattern and a dietary pattern characterized with a high fat and high sugar intake were related to an increased risk of all-cause or CVD mortality (31, 34, 38-40), whereas the inverse association of a prudent dietary pattern (39) or a vegetable rich dietary pattern (40, 41) with all-cause or CVD mortality was occasionally reported in some studies.

Among all dietary pattern scores, the DQI-I total score and the Okinawan diet score showed an inverse association with all-cause mortality in women in this study. Compared with all other dietary pattern scores we examined in this study, the DQI-I total score represents a more comprehensive diet quality score

in view of its calculation covering different aspects of diet, including variety, adequacy, moderation and overall balance, as well as the inclusion of energy and fat intake. The inverse association was consistent with those previously reported based on the DQI derived using another method (30), the Healthy Eating Index (HEI) or alternative HEI (12, 37), as well as the adherence score to the Chinese Food Pagoda (12) and the HANI (13), in which all these diet quality indexes also represent a balanced diet with diverse and adequate nutrient intakes and food group consumption, in particular the consumption of vegetables and fruits.

Though the Okinawan diet has long been considered beneficial for longevity, only few studies reported its association with mortality and suggested that the Okinawan diet was protective against age-related diseases and mortality (42, 43). Our observations that higher Okinawan diet score was associated with lower all-cause mortality were in line with previous findings. The Okinawan diet is characterized by moderate calorie restriction but nutrient dense and antioxidant rich dietary pattern. It is also featured by the use of healthy fat and high consumption of vegetables, soy and legumes. Therefore the anti-inflammatory and radical-scavenging properties as well as the anti-aging property as a result of the mild calorie restriction of the Okinawan diet are thought to be protective against age-related diseases and mortality (43, 44).

We showed an inverse association between the MIND score and the CVD mortality in women. The MIND diet is proposed to slow the decline in cognitive abilities (28), however it is a combination of the Mediterranean and DASH diets, both of which have been found to decrease the risk of cardiovascular conditions, such as hypertension, heart attack and stroke (2, 45). Our study may be the first study reporting an association between the MIND score and CVD mortality. However, its role in cardiovascular disease prevention and ultimately in reducing CVD mortality warrants further investigations.

There are strengths and limitations in this study. The strengths included reliable mortality data based on an official database, inclusion of several non-dietary variables and adjustment for their confounding effect in the analyses. The analysis of dietary patterns instead of single nutrients in relation to mortality also allowed assessment of the interaction among synergistic components in the diet and facilitated the development of food based dietary guidelines to the public (46, 47). However, the present sample size may limit further analysis stratified by other factors, such as age, BMI, smoking, physical activity, as well as the presence or absence of several self-reported diseases. In addition, our sample was of a higher educational standard compared with the general Hong Kong population and the results may not be extrapolated to the general population.

Conclusion

We conclude that higher DQI-I total score and Okinawan diet score were associated with a lower risk of all-cause mortality, and higher adherence to the MIND diet was related to a reduced risk of CVD mortality in Chinese older women, independent of personal lifestyle factors and individual pro- or anti- inflammatory markers.

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Conflict of interest: The authors declared no conflict of interest associated with this paper.

Ethical standard: This study followed the guidelines laid down in the Declaration of Helsinki, and was approved by the Clinical Research Ethics Committee of the Chinese University of Hong Kong.

References

1. Li F, Hou LN, Chen W, Chen PL, Lei CY, Wei Q, et al. Associations of dietary patterns with the risk of all-cause, CVD and stroke mortality: a meta-analysis of prospective cohort studies. Br J Nutr. 2015;113(1):16-24.
2. Chan R, Chan D, Woo J. The association of a priori and a posterior dietary patterns with the risk of incident stroke in Chinese older people in Hong Kong. J Nutr Health Aging. 2013;17(10):866-74.
3. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. Curr Opin Lipidol. 2002;13(1):3-9.
4. van Dam RM. New approaches to the study of dietary patterns. Br J Nutr. 2005;93(5):573-4.
5. Santoro A, Pini E, Scurti M, Palmas G, Berendsen A, Brzozowska A, et al. Combating inflammaging through a Mediterranean whole diet approach: the NU-AGE project's conceptual framework and design. Mech Ageing Dev. 2014;136-137:3-13.
6. Dinu M, Pagliai G, Casini A, Sofi F. Mediterranean diet and multiple health outcomes: an umbrella review of meta-analyses of observational studies and randomised trials. European journal of clinical nutrition. 2018;72(1):30-43.
7. Franceschi C, Campisi J. Chronic inflammation (inflammaging) and its potential contribution to age-associated diseases. J Gerontol A Biol Sci Med Sci. 2014;69 Suppl 1:S4-9.
8. Chen N, Wan Z, Han SF, Li BY, Zhang ZL, Qin LQ. Effect of vitamin D supplementation on the level of circulating high-sensitivity C-reactive protein: a meta-analysis of randomized controlled trials. Nutrients. 2014;6(6):2206-16.
9. Ticinesi A, Meschi T, Lauretani F, Felis G, Franchi F, Pedrolli C, et al. Nutrition and Inflammation in Older Individuals: Focus on Vitamin D, n-3 Polyunsaturated Fatty Acids and Whey Proteins. Nutrients. 2016;8(4):186.
10. Munoz A, Costa M. Nutritionally mediated oxidative stress and inflammation. Oxid Med Cell Longev. 2013;2013:610950.
11. Onvani S, Haghighatdoost F, Surkan PJ, Larijani B, Azadbakht L. Adherence to the Healthy Eating Index and Alternative Healthy Eating Index dietary patterns and mortality from all causes, cardiovascular disease and cancer: a meta-analysis of observational studies. J Hum Nutr Diet. 2017;30(2):216-26.
12. Yu D, Zhang X, Xiang YB, Yang G, Li H, Gao YT, et al. Adherence to dietary guidelines and mortality: a report from prospective cohort studies of 134,000 Chinese adults in urban Shanghai. Am J Clin Nutr. 2014;100(2):693-700.
13. Huang YC, Wahlqvist ML, Lo YC, Lin C, Chang HY, Lee MS. A non-invasive modifiable Healthy Ageing Nutrition Index (HANI) predicts longevity in free-living older Taiwanese. Sci Rep. 2018;8(1):7113.
14. Wong SY, Kwok T, Woo J, Lynn H, Griffith JF, Leung J, et al. Bone mineral density and the risk of peripheral arterial disease in men and women: results from Mr. and Ms Os, Hong Kong. Osteoporos Int. 2005;16(12):1933-8.
15. Census and Statistics Department. Hong Kong 2006 Population Bycensus Thematic Report: Older Persons. Hong Kong: 2006.
16. Washburn RA, Smith KW, Jette AM, Janney CA. The Physical Activity Scale for the Elderly (PASE): development and evaluation. J Clin Epidemiol. 1993;46(2):153-62.
17. Prince M, Acosta D, Chiu H, Scazufca M, Varghese M, Dementia Research G. Dementia diagnosis in developing countries: a cross-cultural validation study. Lancet. 2003;361(9361):909-17.
18. Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, Adey M, et al. Development and validation of a geriatric depression screening scale. A preliminary report. J Psychiatr Res. 1983;17:37-49.

19. Lee HB, Chiu HFK, Kwok WY, Leung CM, Kwong PK, Chung DWS. Chinese elderly and the GDS short form: a preliminary study. Clin Gerontol. 1993;14:37-9.
20. Woo J, Leung SSF, Ho SC, Lam TH, Janus ED. A food frequency questionnaire for use in the Chinese population in Hong Kong: Description and examination of validity. Nutr Res. 1997;17:1633-41.
21. Paul AA, Southgate DAT. McCance & Widdowson's: The Composition of Foods. 4th ed. London: HMSO; 1978.
22. Yang Y, Wang G, Pan X. China Food Composition 2002. 2002 ed. Institute of Nutrition & Food Safety CC, editor. Peking: University Medical Press; 2002.
23. Kim S, Haines PS, Siega-Riz AM, Popkin BM. The Diet Quality Index-International (DQI-I) provides an effective tool for cross-national comparison of diet quality as illustrated by China and the United States. J Nutr. 2003;133(11):3476-84.
24. Woo J, Cheung B, Ho S, Sham A, Lam TH. Influence of dietary pattern on the development of overweight in a Chinese population. Eur J Clin Nutr. 2008;62(4):480-7.
25. Trichopoulou A, Costacou T, Bamia C, Trichopoulos D. Adherence to a Mediterranean diet and survival in a Greek population. N Engl J Med. 2003;348(26):2599-608.
26. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. N Engl J Med. 1997;336(16):1117-24.
27. Mellen PB, Gao SK, Vitolins MZ, Goff DC, Jr. Deteriorating dietary habits among adults with hypertension: DASH dietary accordance, NHANES 1988-1994 and 1999-2004. Arch Intern Med. 2008;168(3):308-14.
28. Morris MC, Tangney CC, Wang Y, Sacks FM, Barnes LL, Bennett DA, et al. MIND diet slows cognitive decline with aging. Alzheimer's Dement. 2015;11(9):1015-22.
29. Willcox BJ, Willcox DC, Todoriki H, Fujiyoshi A, Yano K, He Q, et al. Caloric restriction, the traditional Okinawan diet, and healthy aging: the diet of the world's longest-lived people and its potential impact on morbidity and life span. Ann N Y Acad Sci. 2007;1114:434-55.
30. Seymour JD, Calle EE, Flagg EW, Coates RJ, Ford ES, Thun MJ, et al. Diet Quality Index as a predictor of short-term mortality in the American Cancer Society Cancer Prevention Study II Nutrition Cohort. Am J Epidemiol. 2003;157(11):980-8.
31. Martinez-Gonzalez MA, Zazpe I, Razquin C, Sanchez-Tainta A, Corella D, Salas-Salvado J, et al. Empirically-derived food patterns and the risk of total mortality and cardiovascular events in the PREDIMED study. Clin Nutr. 2015;34(5):859-67.
32. Whalen KA, Judd S, McCullough ML, Flanders WD, Hartman TJ, Bostick RM. Paleolithic and Mediterranean Diet Pattern Scores Are Inversely Associated with All-Cause and Cause-Specific Mortality in Adults. J Nutr. 2017;147(4):612-20.
33. Warensjö Lemming E, Byberg L, Wolk A, Michaëlsson K. A comparison between two healthy diet scores, the modified Mediterranean diet score and the Healthy Nordic Food Index, in relation to all-cause and cause-specific mortality. Br J Nutr. 2018;119(7):836-46.
34. Boggs DA, Ban Y, Palmer JR, Rosenberg L. Higher diet quality is inversely associated with mortality in African-American women. J Nutr. 2015;145(3):547-54.
35. Jones NRV, Forouhi NG, Khaw KT, Wareham NJ, Monsivais P. Accordance to the Dietary Approaches to Stop Hypertension diet pattern and cardiovascular disease in a British, population-based cohort. Eur J Epidemiol. 2018;33(2):235-44.
36. Shah NS, Leonard D, Finley CE, Rodriguez F, Sarraju A, Barlow CE, et al. Dietary Patterns and Long-Term Survival: A Retrospective Study of Healthy Primary Care Patients. Am J Med. 2018;131(1):48-55.
37. Harmon BE, Boushey CJ, Shvetsov YB, Ettienne R, Reedy J, Wilkens LR, et al. Associations of key diet-quality indexes with mortality in the Multiethnic Cohort: the Dietary Patterns Methods Project. Am J Clin Nutr. 2015;101(3):587-97.
38. Atkins JL, Whincup PH, Morris RW, Lennon LT, Papacosta O, Wannamethee SG. Dietary patterns and the risk of CVD and all-cause mortality in older British men. Br J Nutr. 2016;116(7):1246-55.
39. Nanri A, Mizoue T, Shimazu T, Ishihara J, Takachi R, Noda M, et al. Dietary patterns and all-cause, cancer, and cardiovascular disease mortality in Japanese men and women: The Japan public health center-based prospective study. PLoS ONE. 2017;12(4):e0174848.
40. Odegaard AO, Koh WP, Yuan JM, Gross MD, Pereira MA. Dietary patterns and mortality in a Chinese population. Am J Clin Nutr. 2014;100(3):877-83.
41. Shi Z, Zhen S, Zimmet PZ, Zhou Y, Magliano DJ, Taylor AW. Association of impaired fasting glucose, diabetes and dietary patterns with mortality: a 10-year follow-up cohort in Eastern China. Acta Diabetol. 2016;53(5):799-806.
42. Willcox DC, Willcox BJ, Todoriki H, Suzuki M. The Okinawan diet: health implications of a low-calorie, nutrient-dense, antioxidant-rich dietary pattern low in glycemic load. J Am Coll Nutr. 2009;28 Suppl:500S-16S.
43. Rosenbaum MW, Willcox BJ, Willcox DJ, Suzuki M. Okinawa: A Naturally Calorie Restricted Population. In: Everitt AV, Rattan SIS, Le Couteur DG, de Cabo R, editors. Calorie Restriction, Aging and Longevity. Netherlands: Springer Netherlands; 2010. p. 43-53.
44. Willcox BJ, Willcox DC. Caloric restriction, caloric restriction mimetics, and healthy aging in Okinawa: controversies and clinical implications. Curr Opin Clin Nutr Metab Care. 2014;17(1):51-8.
45. Garcia-Rios A, Ordovas JM, Lopez-Miranda J, Perez-Martinez P. New diet trials and cardiovascular risk. Curr Opin Cardiol. 2018;33(4):423-428.
46. Mozaffarian D, Forouhi NG. Dietary guidelines and health-is nutrition science up to the task? BMJ. 2018;360:k822.
47. Schulze MB, Martinez-Gonzalez MA, Fung TT, Lichtenstein AH, Forouhi NG. Food based dietary patterns and chronic disease prevention. BMJ. 2018;361:k2396.