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A dietary pattern rich in olive oil and raw vegetables is associated with lower mortality in Italian elderly subjects

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Dietary habits play an important role in healthy ageing. We have investigated the role of dietary patterns on overall mortality in a large series of Italian elderly, recruited in five EPIC cohorts in Northern (Varese and Turin), Central (Florence) and Southern Italy (Naples and Ragusa).A total of 5611 subjects (72·6 % women) aged 60 years or older, enrolled in 1993–1998, were prospectively followed (median 6·2 years), with 152 deaths (98 women). Four major dietary patterns were identified by using an exploratory factor analysis based on dietary information collected at enrolment. The associations between these dietary patterns and overall mortality were evaluated by Cox models adjusted for potential confounders. The 'Olive Oil & Salad' pattern, characterised by a high consumption of olive oil, raw vegetables, soups and poultry, emerged as being inversely associated with overall mortality in both crude and adjusted models. After adjustment for gender, age and caloric intake, overall mortality was reduced by approximately 50 % in the highest quartile and a significant trend emerged ($P=0·008$). This association persisted after adjusting for several additional confounders (hazard ratio (HR) 0·50; 95 % CI 0·29, 0·86; P for trend = 0·02). An association of the 'Pasta & Meat' pattern (characterised by pasta, tomato sauce, red meat, processed meat, added animal fat, white bread and wine) with increased overall mortality was also suggested, but only for the highest quartile in a multivariate model. Dietary recommendations aimed at the Italian elderly population should support a dietary pattern characterised by a high consumption of olive oil, raw vegetables and poultry.

Dietary patterns: Elderly: Overall mortality: Vegetables: Olive oil

In the last decades, numerous studies have evaluated the relationship between the consumption of foods and food groups as well as the intake of macro- and micro-nutrients and the development of chronic diseases, particularly cancer and cardiovascular diseases. Dietary recommendations have been developed by several agencies (World Cancer Research Fund, 1997; Boyle *et al.* 2003; World Health Organization, 2003) based on available results. Fewer studies have focused on the effects of 'dietary patterns' on human health; this approach could allow the effects of several foods to be studied simultaneously and could bypass methodological problems related to the high inter-correlation among foods and nutrients in diet and multiple testing (Jacques & Tucker, 2001). In addition, this methodology provides an overall description of dietary behaviours and may provide a more comprehensive approach to disease prevention by focusing on the entire diet rather than on just a single food or nutrient. Dietary patterns have been studied in relation to longevity (Trichopoulou *et al.* 1995; Huijbregts *et al.* 1997; Osler & Schroll 1997; Kouris-Blazos *et al.* 1999; Lasheras *et al.* 2000). The majority of these studies evaluated the effect of the Mediterranean dietary pattern as defined by *a priori* scores that reflect the adherence to the essential components of the so-called Mediterranean diet (Trichopoulou *et al.* 1995, 2000) and have reported an inverse association of overall mortality with an increasing score. Another study, which also included two

Abbreviations: HR, hazard ratio; MET, metabolic equivalent.

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Italian cohorts of male subjects living in two rural areas of Northern and Central Italy (Huijbregts *et al.* 1997), found an inverse association between overall mortality and a healthy diet indicator based on the WHO dietary guidelines for the prevention of chronic disease.

Very recently, a modified Mediterranean score has been found to be associated with a reduced mortality among a large sample of elderly Europeans participating in the European Prospective Investigation into Cancer and Nutrition (EPIC) study (Trichopoulou *et al.* 2005).

Overall, different variants of the Mediterranean diet have been identified in Mediterranean countries (Slimani *et al.* 2002) even across geographical areas of the same country, while temporal changes in dietary habits have been described in Mediterranean countries, including Italy (Ferro-Luzzi & Branca, 1995; Turrini *et al.* 2001). Thus, the identification of country-specific dietary patterns and the evaluation of their influence on health status and survival is of interest.

The aim of this study was to evaluate the effects of major dietary patterns, as identified with the *a posteriori* methodology based on observed correlation between foods (Pala *et al.* 2006), on the overall mortality in a cohort of 5611 Italian elderly subjects, who were recruited when aged 60 years or older in the Italian arm of the EPIC study (Palli *et al.* 2003). This analysis has been developed in the frame of the EPIC elderly project aimed to study the potential role of nutrition on the health and longevity of the European elderly as well as to examine the socio-economic and demographic factors that may affect dietary practices and, in turn, the health status of the elderly.

Subjects and methods

Subjects

In the period 1993–1998, the Italian section of the EPIC study completed the recruitment of 47 749 adult volunteers (15 171 men and 32 578 women) in four different areas covered by cancer registries: Varese (12 083 volunteers) and Turin (10 604) in the Northern part of the country, and Florence (13 597) and Ragusa (6403) in Central and Southern Italy, respectively. An associate centre in Naples enrolled 5062 women. Overall, 6031 of these volunteers were aged 60 years or older at enrolment. Detailed information about diet and lifestyle habits, anthropometric measurements and a blood sample were collected for each participant, after they had signed an informed consent form (Palli *et al.* 2003).

Dietary habits

The FFQ was specifically developed for Italian dietary habits and was tested in a pilot phase (Pisani *et al.* 1997). A detailed description of the EPIC-Italy FFQ has been reported elsewhere Pala *et al.* 2003). Briefly, dietary information on the frequency of consumption of more than 120 foods and beverages was collected, checked, coded and computerised by optical reading. In order to capture local dietary behaviours, two slightly different versions were developed and used in Naples and Ragusa. The questionnaires investigated dietary habits in the 12-month period prior to enrolment.

Food items were grouped for the purpose of identifying dietary patterns into food groups based on similarities in ingredients, nutrient profile or culinary usage. Additional subgroupings possibly representing alternative dietary habits were also retained whenever possible: thus the fish group was separated into tinned and fresh; bread was separated into wholemeal and white; and tomatoes and leafy vegetables were separated into cooked and raw. Overall, we had the following food groups for factor analysis: potatoes; leafy vegetables, cooked; leafy vegetables, raw; tomatoes, raw; tomatoes, cooked; root vegetables; cabbage; mushrooms; onion and garlic; mixed salad and mixed vegetables; legumes (pulses) including legumes for soup; other vegetables; citrus fruits; fresh fruit (non-citrus); seeds and nuts; milk; yoghurt; cheese; pasta and other grains (including polenta, couscous, etc.); rice; bread excluding wholemeal bread; wholemeal bread; beef; veal; pork; rabbit (farmed); chicken and turkey; other meat (goat, game, horse, lamb); processed meat; offal; fish, except tinned; crustaceans and molluscs; tinned fish; eggs; seed oils; olive oil; butter; margarine; other animal fats; sugar, honey and jam; chocolate-based confectionery; non-chocolate confectionery; ice-cream; cakes, sweet pies and pastries; puddings (non-milk based); patisserie and biscuits; fruit and vegetable juices; black coffee; coffee with milk; tea; wine; beer; spirits, fortified wines and aperitifs; soups (excluding legume soup); snacks; and pizza (Pala *et al.* 2006).

Lifestyle habits

A standardised lifestyle questionnaire (representing the Italian translation of a common EPIC-wide version and specifically printed in two versions for men and women) was also completed by each participant. Detailed information was collected on reproductive history, physical activity at work and in the household, and leisure-time activities (including walking, cycling and sports), smoking history, alcohol consumption, occupation, educational level and other socio-economic variables. An index of physical activity (PAL) was computed by applying specific MET (metabolic equivalents) to each of the leisure time and household activities, weighted by the number of hours spent on each specific activity as described elsewhere (Salvini *et al.* 2003). Appropriate MET were assigned to each activity according to the report of the Commission of European Community (1993) and with the data from the Italian LARN (Recommended Nutrient Intakes for the Italian population; Società Italiana di Nutrizione Umana, 1996).

A section of the EPIC lifestyle questionnaire requested information about previous diagnosis of myocardial infarction, stroke, diabetes, hypertension, hyperlipaemia, neoplasia and other selected illness.

Anthropometry

Weight, height, and waist and hip circumferences of each participant were measured by trained staff according to the international protocol of the EPIC study. BMI was calculated as weight (kg) divided by height (m) squared. Subjects were classified into different BMI categories according to the WHO guidelines as follow: subjects with a BMI $<18{\cdot}5$ were considered underweight, subjects with a BMI between 18·5 and 24·9 had normal weight; subjects with a BMI between 25 and 29·9 were

considered overweight and subjects with a BMI ≥30 or higher were classified as obese (World Health Organization, 2000). Waist circumference was considered as an indicator of central obesity based on the WHO cut-off points of 88 and 102 cm for females and males, respectively.

Vital status follow-up

The follow-up procedures have been implemented in each centre according to the guidelines prepared by a committee at the co-ordinating centre of the International Agency for Research on Cancer (IARC-Lyon). The ascertainment of vital status was carried out through the linkage with the local town offices and the local Mortality Registries, thereby identifying the deceased subject's date of death and allowing for the retrieval of the death certificate to identify the specific causes of death. The vital status was assessed for the Italian EPIC elderly at the following dates: 31 December 2001 for Varese and Florence, 30 June 2002 for Turin and Ragusa, and 30 June 2001 for Naples. Overall, 6031 EPIC-Italy elderly participants were followed from enrolment until death or end of follow-up whichever came first. At the end of the study period, 189 deceased subjects were identified, while the vital status information was not available for 32 subjects (0·5 %). For the purpose of the present analysis, we excluded 15 subjects who died within the first 12 months of follow-up and 405 subjects who at enrolment reported either a previous myocardial infarction, or a stroke or an invasive cancer (including 22 subjects who died during follow-up).

Statistical analysis

Dietary patterns were developed using exploratory factor analysis as previously described in detail in a dedicated paper (Pala *et al.* 2006). Briefly, exploratory factor analysis was applied to the pre-defined food groups in order to identify a few composite factors able to explain the maximum proportion of the variance present in the original groups. An orthogonal rotation procedure, the varimax rotation, was applied to simplify the factor structure and render it more interpretable. The graphical method known as the Scree test was used to identify the four factors to be retained (Cattell, 1966). Foods groups with an absolute loading >0·30 were considered to contribute importantly to that specific factor; a specific list showing the structure of the four rotated factors and the cumulative variance explained is given in Appendix 1. Factor scores for each pattern were calculated and assigned to each study subject. Scores were categorised in gender-specific quartiles based on the distribution in the entire EPIC-Italy elderly cohort.

Cox regression models, with the length of follow-up as the primary time variable, were used to estimate hazard ratios (HR) with 95 % CI for the three upper quartiles in comparison with the lowest category of each factor score as reference. The multivariate analyses were all stratified by recruitment centre to account for possible differences in data collection and follow-up. We first estimated crude HR with 95 % CI, and thereafter we estimated HR with 95 % CI adjusted for sex, age (years) and log-transformed caloric intake (Model A). We also applied a second model (Model B) which, in addition, included terms for BMI (over and under 25), waist (continuous), smoking status (never smokers, ex-smokers and two categories for current smokers: 1–20 cigarettes/day, >20 cigarettes/day), years of education (continuous), civil status (married yes/no), hypertension at enrolment (yes/no), physical activity in the household and leisure-time activities as estimated by PAL (the highest tertile *v.* all others). All these characteristics have been shown to be related to both dietary patterns (Pala *et al.* 2006) and mortality. The role of selected medical conditions as reported by each participant at enrolment (diabetes and hyperlipaemia) was also evaluated but these were not added into the model because they did not materially modify the results.

The analyses were also carried out separately by gender and geographical area. Due to the small number of deaths available for each centre, the latter analysis was carried out by grouping the Northern (Varese and Turin) and Central–Southern (Florence, Naples and Ragusa) centres.

All analyses were performed using SAS statistical software (Version 8.2; SAS Institute, Cary, NC, USA. A P value of <0·05 was considered statistically significant.

Results

A total of 5611 subjects (72·6 % women) were available for the analyses, with a median follow-up of 6·2 years. The distribution of EPIC-Italy elderly participants by gender and selected characteristics at enrolment is shown in Table 1. Most of the study subjects reported that they were married (68·9 % among women and 94·6 % among men), while widows and widowers were 19·8 and 1·3 %, respectively; 34·8 % of men and 47·6 % of women reported having attended only primary school, whereas 8·4 and 8·0 %, respectively, had a university degree.

At enrolment, among men, 54·6 % were overweight and 15·5 % obese. Among women, the proportion of overweight and obese subjects was 45·4 and 19·8 %, respectively. Never smokers were 27·1 % for men and 66·2 % for women. Most subjects were classified as sedentary according to an index of physical activity (87·3 % males and 68·8 % females). The proportions of subjects who, at enrolment, reported a previous diagnosis of hypertension, hyperlipaemia and diabetes were 35·3, 34·9 and 4·3 %, respectively.

A total of 35 122 person-years (9382 for men) were available for analysis (Table 2); 11·402 for Varese, 10·768 for Florence, 6862 for Turin, 3454 for Naples and 2636 for Ragusa. The median age at enrolment was 62·3 years (range 60·0–72·2) among men and 62·7 (range 60·0–77·8) among women. Overall, 152 deceased subjects were included in the present analysis with a median age of 67·5 years at death (range 62·1–78·8). Among the 152 deceased subjects, 98 (64·5 %) were women with a median age of 68·5 years at death (range 62·1–78·8). Overall, 93 (61·2 %) deceased subjects had been enrolled in the two Northern Italy centres (Table 2). The underlying causes of death were classified as follows: 83 deaths as due to cancer, 37 to cardiovascular disease and 32 to all other causes combined.

Dietary patterns

Four major dietary patterns, explaining 21 % of the variance in the original dietary variables, have been identified (Pala *et al.*

Table 1. Distribution of 5611 EPIC-Italy elderly participants, overall and by gender, according to selected characteristics (EPIC-Italy 1993–2002)

	Males		Females		Total	
Characteristics	*n**	%	*n*	%	*n*	%
Civil status						
Married	1272	94·6	2779	68·9	4051	75·3
Widow/widower	18	1·3	799	19·8	817	15·2
Divorced/unmarried	54	4·0	458	11·4	512	9·5
Educational level						
Primary school	533	34·8	1935	47·6	2468	44·1
Secondary school	338	22·1	863	21·2	1201	21·5
High school	531	34·7	944	23·2	1475	26·3
University	128	8·4	327	8·0	455	8·1
Smoking history						
Never smoker	409	27·1	2698	66·2	3107	55·6
Former smoker	764	50·6	668	16·4	1432	25·6
Current smoker	337	22·3	709	17·4	1046	18·7
BMI categories						
Normal (<25)	455	29·6	1418	34·8	1873	33·4
Overweight (25–29·99)	838	54·6	1851	45·4	2689	47·9
Obese (≥30)	243	15·8	806	19·8	1049	18·7
Central obesity (waist)†						
No	1104	75·2	2676	66·1	3780	68·6
Yes	364	24·8	1370	33·9	1734	31·5
Hypertension‡						
No	1043	68·0	2579	63·5	3622	64·7
Yes	491	32·0	1485	36·5	1976	35·3
Diabetes‡						
No	1475	96·0	3896	95·6	5371	95·7
Yes	61	4·0	179	4·4	240	4·3
Hyperlipaemia‡						
No	1050	68·5	2596	63·9	3646	65·2
Yes	484	31·6	1466	36·1	1950	34·9
Physical activity (PAL)						
Sedentary (<1·6)	1341	87·3	2804	68·8	4145	73·9
Moderately active (1·6–1·74)	127	8·3	1152	28·3	1279	22·8
Active (≥1·75)	68	4·4	119	2·9	187	3·3
Total	1536	27·4	4075	72·6	5611	100·0

* Due to some missing data, not all numbers add up to the total.
† WHO cut off values: ≥88 cm women; ≥102 cm men.
‡ Reported at baseline interview.

2006). Briefly, Pattern no. 1, labelled as 'Prudent' was characterised by a high consumption of cooked vegetables, legumes, fish, and seed oil as the main added fat. Pattern no. 2, labelled as 'Pasta & Meat', was characterised by a high consumption of pasta and other grains, tomato sauce, red and processed meats, added animal fat, white bread and wine; on the other hand, this pattern showed a low consumption of yoghurt. Pattern no. 3, named 'Olive Oil & Salad', was characterised by a high consumption of olive oil as added fat, raw vegetables (tomatoes, leafy and root vegetables), soups and white meat (chicken and turkey). Pattern no. 4 labelled as 'Sweet & Dairy' was characterised by high consumption of added sugar, cakes, ice-cream, coffee, eggs, butter, milk and cheese.

Table 2. Distribution of the 5611 EPIC-Italy elderly, person-years (PY) and number of deaths observed during the follow-up, overall and by gender and centre (EPIC-Italy 1993–2002)

	Males			Females			Total		
EPIC-Italy	Study subjects	PY	Deaths	Study subjects	PY	Deaths	Study subjects	PY	Deaths
Northern									
Turin	539	3633	25	500	3229	7	1039	6862	32
Varese	417	2121	9	1395	9281	52	1812	11 402	61
Central									
Florence	374	2186	15	1444	8582	23	1818	10 768	38
Southern									
Naples	–	–	–	558	3454	12	558	3454	12
Ragusa	206	1442	5	178	1194	4	384	2636	9
Total	1536	9382	54	4075	25 740	98	5611	35 122	152

The distribution of study subjects in the quartiles of the four specific pattern scores is shown in Table 3, according to gender and other major individual characteristics. Subjects in the higher score quartiles of the 'Prudent' pattern were more frequently females, more educated, more likely to be single, former smokers and obese; they also reported more frequently a diagnosis of diabetes, hyperlipaemia or hypertension. Higher scores for the 'Pasta & Meat' pattern were more likely among married males, current smokers, overweight or obese subjects. Subjects in the higher scores for the 'Olive oil & Salad' pattern were more frequently males, married, with a higher school education, leaner and more physically active. Subjects in the higher scores of 'Sweet & Dairy' pattern were more likely to have a higher education, to be more physically active and with a normal weight.

Dietary patterns and overall mortality

The 'Olive Oil & Salad' pattern (Pattern no. 3) was inversely associated with all-cause mortality (Table 4). The univariate analysis, stratified by centre, showed a 56 % lower risk of death from all causes in subjects in the highest quartile with respect to those in the lowest quartile of this score, with a statistically significant trend ($P=0{\cdot}001$). After adjustment for gender, age and total caloric intake (Model A), the overall mortality risk was still reduced by approximately 50 % in subjects classified in the upper quartile of this score. A statistically significant trend was evident across quartiles ($P=0{\cdot}008$). This association persisted when we applied Model B including terms for several additional confounders. In separate analyses by gender, the association of Pattern no. 3 'Olive Oil & Salad' with overall mortality showed similar results in the two sexes (based on the same models previously described), although the results did not reach statistical significance possibly because of smaller numbers.

In the analyses carried out separately for the two main geographical areas, by combining the two Northern (Turin and Varese) and the three Central Southern centres (Florence, Naples and Ragusa), a similar inverse association of 'Olive Oil & Salad' pattern with overall mortality tended to be evident in both areas (data not shown).

We also explored the relationship between each food or food group contributing to the 'Olive Oil & Salad' pattern with an absolute loading greater than 0·30 and overall mortality, with a series of analyses based on both Model A and the more complex Model B. While selected food groups were significantly associated with reduced mortality in the analyses based on the simpler Model A (white meat, $P=0{\cdot}019$; root vegetables, $P=0{\cdot}004$), only one association persisted in the more complex Model B (root vegetables, $P=0{\cdot}02$).

An increased overall mortality was observed among subjects classified in the highest quartile of the 'Pasta & Meat' pattern (Pattern no. 2) when Model A was applied (HR 1·68; 95 % CI 1·01, 2·80) but the P for trend across quartiles failed to reach statistical significance; this association tended to be even weaker when the more complex Model B was applied.

The other patterns 'Prudent' (Pattern no. 1) and 'Sweet & Dairy ' (Pattern no. 4) were not significantly associated with mortality, either overall or in specific subgroups.

Discussion

This prospective study, carried out in a large multicentre cohort of 5611 Italian elderly subjects recruited within the EPIC-Italy project, showed an inverse association between overall mortality and a specific dietary pattern characterised by a high consumption of olive oil as added fat, raw vegetables (particularly lettuce and tomatoes), soups and poultry as animal protein source, after a 6-year follow-up. These results did not change substantially when men and women were analysed separately, or when the analyses were carried out separately for Northern and Central Southern Italian EPIC recruitment centres. The inverse association of the 'Olive Oil & Salad' pattern with overall mortality is in agreement with the protective effect of several of its single food components. Olive oil is the most characteristic component of this pattern, and accumulating evidence suggests that it may have a role in the prevention of coronary heart disease and cancer, and may influence survival (Owen *et al.* 2000). Although olive oil is usually the main source of MUFA in the traditional Mediterranean diet (Dougherty *et al.* 1987) and although a high MUFA intake has been shown to improve the lipid profile, thus reducing cardiovascular risk (Trevisan *et al.* 1990), experimental studies indicate that the protective effect of olive oil is also related to a series of compounds with potent antioxidant properties, particularly phenols such as hydroxy-tyrosol (Visioli & Galli, 2002; Salvini *et al.* 2006). The other relevant components of this pattern, leafy vegetables and tomatoes, are an important source of micronutrients with antioxidant properties, fibre and biologically active compounds. All of the latter provide a protective effect against a wide range of diseases, including cancer and cardiovascular diseases. While olive oil was the main added fat used in all the EPIC-Italy cohorts, subjects with a high score for this pattern were characterised by a particularly high consumption. As expected, olive oil consumption was strongly related to that of raw vegetables. The consumption of such vegetables together with olive oil might contribute to an improvement of the antioxidant status, because of the combination of the antioxidants from the vegetables and those from olive oil (especially when an extra-virgin olive oil is used). White meat is a relevant component of this pattern, and its consumption (in contrast to red meat) has been linked with a reduced risk of coronary heart disease (Hu *et al.* 1999, 2000). Moreover, white meat has not been directly linked to an increased cancer risk as has been found for other types of meat, particularly red meat and processed meats (World Cancer Research Fund, 1997; Norat *et al.* 2005). On the other hand, we have to consider that subjects in the highest quartile of this pattern were more likely to have a high educational level and normal weight, and to be physically active; all these conditions could contribute to increased survival. Although the association between the Olive Oil & Salad pattern and overall mortality also persisted when adjusting for all these conditions, some residual confounding cannot be completely ruled out.

Pattern no. 1, labelled as the 'Prudent' pattern, might somehow appear similar to a Mediterranean dietary pattern, including a large variety of vegetables, mainly consumed cooked, in addition to legumes and fish, but it was not associated with a lower mortality. This pattern represents a low-cost version of

Table 3. Percentage distribution of study participants according to selected demographic and lifestyle characteristics by quartiles (Q1–Q4) of the four dietary patterns identified in the EPIC elderly cohort (EPIC-Italy 1993–2002)

	Prudent					Pasta & Meat					Olive Oil & Salad					Sweet & Dairy				
Dietary pattern	Q1	Q2	Q3	Q4	χ^2 *P*	Q1	Q2	Q3	Q4	χ^2 *P*	Q1	Q2	Q3	Q4	χ^2 *P*	Q1	Q2	Q3	Q4	χ^2 *P*
	%					%					%					%				
Sex																				
Male	28·0	30·7	30·9	20·0		6·5	16·0	28·9	58·1		21·7	25·2	29·0	33·6		28·5	28·2	26·6	26·2	
Female	72·0	69·3	69·1	80·0	<0·0001	93·5	84·0	71·1	41·9	<0·0001	78·3	74·8	71·0	66·4	<0·0001	71·5	71·8	73·4	73·8	0·4394
Civil status																				
Married	73·3	77·4	79·2	71·3		65·9	72·4	77·4	86·1		69·7	75·5	77·6	78·6		74·6	76·0	76·4	74·2	
Widow/widower	17·2	13·6	12·7	17·3		21·0	16·9	14·0	8·4		19·6	14·5	13·7	12·8		14·3	15·1	15·4	15·9	
Divorced/unmarried	9·5	9·0	8·1	11·4	<0·0001	13·1	10·7	8·6	5·5	<0·0001	10·7	10·0	8·6	8·6	<0·0001	11·1	8·9	8·2	9·9	0·2240
Educational level																				
Primary school	49·7	46·3	42·8	37·5		42·0	45·2	44·9	44·2		45·9	45·2	43·7	41·5		50·9	44·9	41·2	39·3	
Secondary school	21·5	20·4	20·9	23·0		22·5	21·3	21·5	20·5		22·1	18·6	22·6	22·4		19·6	22·2	21·0	23·1	
High school	23·7	26·4	26·7	28·6		25·4	26·1	25·8	28·0		23·7	26·6	26·7	28·4		22·9	24·5	28·9	29·0	
University	5·1	6·9	9·6	10·9	<0·0001	10·1	7·4	7·8	7·3	0·1114	8·2	9·6	7·0	7·7	0·0060	6·6	8·4	8·9	8·6	<0·0001
Smoking history																				
Never smoker	57·9	55·6	54·6	54·4		63,9	63,5	52,8	42,2		54·1	56·9	57·0	54·5		55·6	57·5	53·0	56·4	
Former smoker	22·8	27·1	28·8	23·9		21·8	20·2	26·6	34·0		23·2	23·3	26·1	29·9		26·2	26·2	26·1	24·1	
Current smoker	19·3	17·3	16·6	21·7	0·0002	14·3	16·3	20·6	23·8	<0·0001	22·7	19·8	16·9	15·6	<0·0001	18·2	16·3	20·9	19·5	0·0475
BMI categories																				
Normal (<25)	36·1	35·4	33·5	28·6		39·1	34·8	31·0	28·6		33·2	34·9	34·6	30·9		32·0	32·5	33·1	35·9	
Overweight (25–29·99)	46·3	49·6	50·2	45·6		45·4	46·8	48·6	50·9		46·3	49·2	47·8	48·3		46·9	48·7	49·8	46·2	
Obese (≥30)	17·6	15·0	16·3	25·8	<0·0001	15·5	18·4	20·4	20·5	<·0001	20·5	15·9	17·6	20·8	0·0062	21·1	18·8	17·0	17·9	0·0387
Central obesity (waist)*																				
No	72·0	74·6	71·9	55·8		72·8	70·1	65·2	66·1		62·8	72·3	69·9	69·3		64·4	66·6	71·6	71·5	
Yes	28·0	25·4	28·1	44·2	<0·0001	27·2	29·9	34·8	33·9	<0·0001	37·2	27·7	30·1	30·7	<0·0001	35·6	33·4	28·4	28·5	<0·0001
Hypertension†																				
No	65·9	67·4	63·9	61·6		64·3	64·9	64·6	64·9		64·7	65·3	64·6	64·2		63·3	63·3	65·7	66·4	
Yes	34·1	32·6	36·1	38·4	0·0077	35·7	35·1	35·4	35·1	0·9884	35·3	34·7	35·4	35·8	0·9520	36·7	36·7	34·3	33·6	0·1828
Diabetes†																				
No	95·8	96·4	96·4	94·3		96·2	96·1	95·1	95·4		95·7	95·6	96·1	95·4		92·2	95·3	97·2	98·1	
Yes	4·2	3·6	3·6	5·7	0·0175	3·8	3·9	4·9	4·6	0·3678	4·3	4·4	3·9	4·6	0·8073	7·8	4·7	2·8	1·9	<0·0001
Hyperlipaemia†																				
No	68·5	67·0	61·4	63·7		58·5	63·7	67·2	71·2		69·5	65·0	64·1	62·1		59·4	63·4	67·2	70·6	
Yes	31·5	33·0	38·6	36·3	0·0003	41·5	36·3	32·8	28·8	<0·0001	30·5	35·0	35·9	37·9	0·0005	40·6	36·6	32·8	29·4	<0·0001
Physical activity (PAL)																				
Sedentary (<1·6)	76·2	75·4	73·1	70·7		70·9	71·7	76·2	76·7		76·2	75·4	73·3	70·5		74·3	74·6	75·3	71·3	
Moderately active (1·6–1·74)	21·2	21·9	22·8	25·9		26·0	25·4	21·4	18·4		21·0	21·8	23·4	25·0		22·7	22·3	22·0	24·2	
Active (≥1·75)	2·6	2·7	4·7	3·4	0·0005	3·1	2·9	4·4	4·9	<0·0001	2·8	2·8	3·3	4·5	0·0066	3·0	3·1	2·7	4·6	0·0567

* WHO cut-off values: ≥88 cm women; ≥102 cm men.
† Reported at baseline interview.

Table 4. Association between overall mortality and the four major dietary patterns (gender-specific quartiles) in 5611 elderly EPIC-Italy participants: crude and multivariate adjusted estimates of hazard ratios (HR) and 95 % CI (EPIC-Italy 1993–2002)

	Crude*		Model A†		Model B‡	
Dietary pattern	HR	95 % CI	HR	95 % CI	HR	95 % CI
No. 1: 'Prudent'						
I (low)	1	–	1	–	1	–
II	0·85	0·55, 1·31	0·88	0·57, 1·36	0·99	0·63, 1·54
III	0·79	0·51, 1·24	0·88	0·56, 1·40	0·93	0·58, 1·51
IV	0·76	0·45, 1·30	0·80	0·46, 1·40	0·85	0·47, 1·53
P for trend		0·25		0·45		0·59
No. 2: 'Pasta & Meat'						
I (low)	1	–	1	–	1	–
II	1·03	0·66, 1·60	1·14	0·73, 1·79	1·07	0·67, 1·70
III	0·87	0·54, 1·39	1·08	0·66, 1·76	0·99	0·59, 1·64
IV	1·19	0·77, 1·85	1·68	1·01, 2·80	1·37	0·80, 2·34
P for trend		0·60		0·08		0·34
No. 3: 'Olive Oil & Salad'						
I (low)	1	–	1	–	1	–
II	0·74	0·48, 1·13	0·77	0·50, 1·18	0·78	0·50, 1·21
III	0·67	0·44, 1·05	0·72	0·46, 1·12	0·76	0·48, 1·20
IV	0·44	0·27, 0·72	0·49	0·29, 0·82	0·50	0·29, 0·86
P for trend		0·001		0·008		0·02
No. 4: 'Sweet & Dairy'						
I (low)	1	–	1	–	1	–
II	0·84	0·54, 1·31	0·92	0·59, 1·45	0·90	0·56, 1·45
III	0·71	0·45, 1·13	0·84	0·51, 1·37	0·87	0·52, 1·45
IV	0·95	0·61, 1·46	1·34	0·80, 2·27	1·47	0·85, 2·54
P for trend		0·68		0·49		0·25

* Stratified by centre.

† Estimated by a series of Cox proportional models (stratified by centre) adjusted for sex, age (years) and caloric intake (log-transformed).

‡ Estimated by a series of Cox proportional models (stratified by centre) adjusted for sex, age (years), BMI (over and under 25), waist (continuous), smoking status (never smokers, ex-smokers and two categories for current smokers: 1–20 cigarettes/day, >20 cigarettes/day), years of education (continuous), civil status (married yes/no), hypertension at enrolment (yes/no), PAL (the highest tertile v. the others) and caloric intake (log-transformed).

the typical Southern diet, rich in fish, legumes and cooked vegetables (deep-fried or stir-fried), with seed oil replacing the traditional and more expensive olive oil (Pala *et al.* 2006). This pattern was the first to emerge in our analyses probably because it is relatively easy to identify a pattern characterised by seed oil consumption in a population largely using olive oil, particularly if the consumption of seed oil is strictly associated with other specific foods (such as fish). However, it was also shown that the 'Prudent' pattern was positively associated, particularly in women, with conditions such as hypertension, hypercholesterolaemia, overweight and obesity, conditions that might have directed this group of women towards the consumption of seed oils, as recommended, until recently, by medical doctors and in particular by cardiologists (Pala *et al.* 2006). Although all these conditions were controlled for in the statistical analyses, some residual confounding could have weakened the association of this pattern with overall mortality. In a previous analysis in the larger series of EPIC adults (Fusconi *et al.* 2003), seed oil consumption was significantly related to plasma levels of PUFA, and a correlation between fish consumption and *n*-3 fatty acids also emerged. The latter correlation (and the high consumption of cooked vegetables) 'a priori' might have suggested a protective effect of this pattern against overall mortality that however did not emerge in our data. It is of interest that the role of *n*-3 fats has been discussed recently (Geleijnse *et al.* 2006; Hooper *et al.* 2006; MacLean *et al.* 2006).

The 'Pasta & Meat' pattern is characterised by a high consumption of several traditional foods based on refined grains (particularly pasta and white bread), but also red meat, processed meat, and wine, the major source of alcohol in this population. Although it is characterised by some potentially 'protective' ingredients (such as tomato sauce), overall this pattern shares some characteristics (high intake of red meat and processed meat, consumption of refined cereal products and use of added animal fats) with the Western-style diet that have been associated with coronary heart diseases (Hu *et al.* 2000), type II diabetes (van Dam *et al.* 2002) and colorectal cancer risk (Slattery *et al.* 1998; Fung *et al.* 2003). Red and processed meats have been linked to an increased risk of colorectal cancer, both in European (Norat *et al.* 2005) and in US prospective studies (Giovannucci *et al.* 1994). Moreover, studies carried out in vegetarian subjects have often shown reduced risks for both cardiovascular disease and all-cause mortality (Snowdon, 1988; Beeson *et al.* 1989; Fraser & Shavlik, 1997), although a collaborative re-analysis of five prospective studies did not show a reduced risk for cerebrovascular disease and cancer at various sites in non-meat eaters (Key *et al.* 1999). In our cohort, this pattern emerged as characteristic of less educated men, across all study centres, and the adherence to this pattern increased with increasing

BMI and cigarette smoking (Pala *et al.* 2006). This pattern tended to be associated with a higher mortality in a simplified model but, when a more complex model (including terms for several additional confounders such as education, BMI, waist circumference and smoking status) was applied, the association with overall mortality disappeared. It is noteworthy that, overall, this pattern was the only one with a factor loading negatively ($>0{\cdot}30$); this specific food item was represented by yoghurt.

In our prospective study, dietary data were collected through validated dietary questionnaires specifically designed to capture local dietary habits in the Italian population, and local dietary patterns were derived with an *a posteriori* methodology based on observed correlation between foods. It is notable that while no specific association was evident in the Italian cohorts when the *a priori* modified Mediterranean score was applied in another analysis also involving several other countries (Trichopoulou *et al.* 2005), one of the four *a posteriori* major patterns identified in the present paper, the 'Olive Oil & Salad' pattern that shares some characteristics with the so-called Mediterranean diet, was clearly associated with a lower morality. It is possible that due to the large geographic variability of dietary habits across the Mediterranean countries together with temporal changes that have occurred more recently, a locally developed version of a Mediterranean pattern might play a more beneficial role in health status and survival. In addition, one has to consider that different questionnaires aimed to collect dietary information in separate countries might be characterised by different levels of detail and reliability.

Information on non-dietary variables that could be considered as potential confounders in the analyses were collected through a common questionnaire. The prevalence of a series of well-known non-dietary risk factors such as smoking, overweight and obesity is consistent with the results of other Italian studies focused on elderly subjects (Farchi *et al.* 2004). The adjustment for these above-mentioned factors has to be considered mandatory in studies investigating dietary influence on health and survival. In addition, standardised follow-up procedures have been developed in all Italian EPIC centres in order to ensure a complete mortality follow-up. In fact, the percentage of subjects for which vital status information was not available at the end of follow-up was very low.

The number of deaths available for the analysis was still relatively small, and this precluded the possibility of performing analyses according to specific causes of deaths. However, from a public health point of view, these results based on overall mortality appear particularly relevant.

Overall, our results suggest that a particular food pattern, characterised by a frequent consumption of raw vegetables, poultry (as source of animal protein) and olive oil (as added fat) can represent an appropriate diet for the elderly in order to improve survival and the maintenance of health.

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Appendix 1. Factor analysis in the EPIC-Italy elderly cohort (*n* 5611): structures of the four retained rotated factors (dietary patterns 1–4) with foods and food groups ranked by their specific loading coefficients (>0·30)

Dietary patterns	Foods and food groups	Loading coefficients	Cumulative variance explained (%)
No. 1: 'Prudent'	Other vegetables		0·69
	Legumes		0·62
	Leafy vegetables – cooked	0·54	
	Onion, garlic	0·53	
	Cabbage	0·44	8
	Fish	0·42	
	Crustaceans, molluscs	0·42	
	Mushrooms	0·37	
	Seed oil	0·33	
	Fresh fruit (non-citrus)	0·33	
	Tomatoes – cooked	0·33	
	Nuts and seeds	0·30	
No. 2: 'Pasta & Meat'	Pasta & other grains	0·62	
	Beef	0·61	
	Other animal fat	0·59	
	Tomatoes – cooked	0·50	13
	Wine	0·49	
	White bread	0·44	
	Processed meat	0·43	
	Pork	0·38	
	Yoghurt	−0·30	
No. 3: 'Olive Oil & Salad'	Olive oil	0·77	
	Tomatoes – raw	0·67	
	Leafy vegetables – raw	0·62	17
	Root vegetables	0·55	
	Soups	0·33	
	Chicken and turkey	0·31	
No. 4: 'Sweet & Dairy'	Sugar, honey, jam	0·46	
	Ice-cream	0·44	
	Chocolate-based confectionery	0·43	
	Cakes and puddings	0·43	
	Coffee	0·39	21
	Processed meat	0·36	
	Eggs	0·35	
	Milk	0·34	
	Butter	0·33	
	Cheese	0·31	
	Patisserie and biscuits	0·31	